

ENAMELING ON METAL

ENAMELLING ON METAL

A PRACTICAL MANUAL ON ENAMELLING'S
AND PAINTING ON ENAMEL AS APPLIED
PARTICULARLY TO GOLD AND SILVER
WARE AND ART METAL WORK

BY
LOUIS-ELIÈ MILLENET

Translated from the French

BY
H. DE KONINGH

WITH FIVE PLATES OF ILLUSTRATIONS



LONDON
CROSBY LOCKWOOD AND SON
7, STATIONERS' HALL COURT, LUDGATE HILL

1926

PRINTED IN GREAT BRITAIN BY
WILLIAM CLOWES AND SONS, LTD., LONDON AND BLCLES.

PREFACE

BY THE LATE GEORGES HANTZ

(Formerly Director of the "Musée des Arts Décoratifs de Genève")

THE *Manuel Pratique de l'émaillage sur metaux* (a practical treatise on enamelling on metals), which M. Louis-Eliè Millenet presents to all who are interested in the delicate art of enamelling and its various manifestations, is above all things the outcome of the experiments and experience of several generations of professionals, as the author is a descendant of enamellers, painters on enamels, and manufacturers of enamels and colours for painting on enamel—the ancient Genevan family of "Dufaux," of whom interesting details are given in the *Dictionnaire des artistes suisses*.

M. Millenet—artist himself, having handled pencil and brush, the "point" of the enameller and crucible of the enamel manufacture—now devotes himself entirely to the manufacture of enamels and colours, perpetuating the traditions of his forebears, while adapting them to the requirements of modern processes. He was therefore fully qualified to undertake the extremely useful work which we now present to the public.

This manual, undertaken without the slightest intention of competing with the many and learned

works already published on the same subject, has this advantage over most of them, that it is written by a craftsman who is not only addressing fellow-craftsmen, who by the light of their own experience can judge the varied nature of his, but who appeals also, and above all, to the seeker who desires initiation into this art of enamelling, the noble and inseparable auxiliary of the decorative arts in the splendid epoch of artistic revival.

M. Millenet has retained in the plan of his work certain terms, hallowed by long usage, as for instance in his classification of enamels, which we in our profession of instructor have been obliged to employ in order to make ourselves clear to workmen and artisans connected with the craft of enamelling. The term "translucid enamel" is here actually and especially applied to enamel "au jour," that is, enamel through which light passes freely and without hindrance as it would through the rose window of a cathedral or such like, heightening the play of colour in the rich transparent masses.

Really, this is theoretically incorrect.

Translucidity is only relatively and not actually transparency. The best experimental example one can give, is that of a tumbler of clear crystal, filled with equally pure water; an article placed behind that tumbler can be seen clearly and sharply in all its details: that is transparency. The moment a few drops of absinthe or milk are added to the water, thus clouding it, the article placed behind can only be seen indistinctly; yet light passes through: that is translucency. Pure clear flux is transparent, opal enamels in the lump and in varying degrees are translucent.

These definitions have never been clearly settled in the language of the craft, yet it is this language hallowed by use that M Millenet has had to employ. It was nevertheless necessary to define these terms, which I have endeavoured to do as succinctly as possible. I might add that these varying interpretations are the cause of regrettable misunderstandings, and it would be well if they could be cleared up definitely.

It follows that work “à jour” (plique à jour enamels), whether bent up into cloisons, saw-pierced, or stamped out, can be either transparent or translucent according to the nature of the enamel employed.

The practical nature of the work can be seen from its arrangement : the division of the chapters allowing the student, by the aid of the Table of Contents, to find, readily, the object of his researches.

The questions of workshops, hygiene, furniture, and plant are treated with a perfect knowledge of the requirements of the craft ; thus from the start giving every chance of the satisfactory issue of the work ; in itself no small thing.

Then come the technical questions and their application to the many and difficult manifestations of the craft. The author enters into infinite details which may appear puerile to those broken-in to the “tricks of the trade,” if one may employ the term sacred to various little secrets, property of each “shop,” handed down with the furniture from the master to the foreman who takes over.

Nevertheless, this voluntary particularity of detail is one of the consequences of the meticulous care which is at the base of the craft, in common with other branches which form part of its manifestation,

such as engraving and chasing, preparing the "cells" for the enameller, on articles of goldsmithing, watches, and jewellery. This minute care is, after all, typical of the Genevans, at any rate in anything which pertains to the manufacture of the watch, its movement, its case, and its decoration.

The process of fluxing, for example, which is one of the traditions of the "Emaux de Genève" (Genevan enamels) and which enjoys a well-deserved reputation, is treated methodically and practically, and this is to cite only one section taken from the whole of the manual. This work in fact, quite Genevan, appears to us to have come at the psychological moment. Political events of these days have, and will always have, a reflex action on those of the economic order; our city of Geneva is called upon to play a preponderating rôle in the artistic industries, secular industries which have carried its name and reputation, particularly in all concerning enamels, far across the seas.

However modest and unpretentious this *Practical Manual of Enamelling on Metal* may be, it seems to us that it should take its place in the movement, artistic and industrial, which is going on with gathering force, and while recalling to mind the very special aptitude of the Genevan artisans and craftsmen, render signal service to all those to whom it is addressed.

G. H.

AUTHOR'S PREFACE

THE ancient and noble art of enamelling has had, through the centuries, many historians, erudite archæologists or commentators of many orders who have patiently fixed its far-off origins and described its multiple evolutions throughout the ages.

In great number, the glorious examples of this art of the fire are housed in the museums of the principal cities or are the pride of private collections. These specimens, fashioned of a material of incomparable richness, resisting the ravages of time, fascinate the cultivated public while shyly unfolding the secrets of their delicate technique, so difficult of achievement.

With regard to this same technique, so alluring and elusive, we may say that from the Middle Ages down to the present time, it has been honoured with a mass of literature as abundant as it is superficial.

Certain authors have even dowered the art with voluminous works, serving up empirical and out-of-date formulæ, without ever overpassing the bounds of a compilation both servile and blind.

Invariably trammelled by the bonds of cold theory, without experimental verification, these publications have never attained any practical end

The fundamental failing of this literature, viewed from the angle of the material difficulties experienced

AUTHOR'S PREFACE

daily by artist and craftsman, lies in the fact that never, so far as we have ascertained, has a member of the craft taken upon himself to set down, in however brief a manner, but clearly and soundly, his own practical knowledge for the benefit of whomsoever desired to initiate or perfect himself in the difficult art of enamelling metals.

It is therefore with a firm desire to fill in an undoubted blank in this domain, and in response to oft-repeated requests, that I have set myself the task of compiling this modest manual, having no literary talent, and hampered by the many repetitions necessary for clarity of explanation, but having for sole aim, the desire to impart that practical information which must be possessed by any one desirous of embellishing metals with enamel—that material so sumptuous, so highly decorative.

LOUIS ELIÈ MILLENET.

FOREWORD TO THE ENGLISH EDITION

It was with great pleasure that, as the result of a chance remark of mine, I received an invitation from my old friend M. L. E. Millenet to undertake the translation of his manual of enamelling on metals. I had read his work when the first French edition was published in 1917, and being convinced from my own experience of over forty years as an enameller that this was the most complete and practical work yet published on the subject, I was glad to be able to accede to his request, feeling that with my knowledge of both the French and English technical terms I should be able to do justice to M. Millenet's profound knowledge of the craft—while putting it in a form acceptable to English-speaking readers. While it is obvious that no text-book, however clearly written or however extensive the author's knowledge, can ever take the place of practical work, yet I am convinced that a careful study of the manual will enable even the tyro to make a successful start in this most fascinating art, while the worker of experience will be sure to find many things of interest. It is therefore with a great spirit of confidence that this translation is offered to the English-speaking public.

H. DE KONINGH

D'ARBLAY STREET,
LONDON, W.

CONTENTS

	PAGE
PREFACE	v
AUTHOR'S PREFACE	ix
FOREWORD TO THE ENGLISH EDITION	xi

PART I

ENAMELLING ON METAL

CHAPTER

I. DEFINITION AND CLASSIFICATION OF ENAMELS	1
II. WORKSHOPS	3
III. FURNITURE, PLANT, AND TOOLS	5
IV. FURNACES AND ACCESSORIES	8
V. ACIDS AND FILTERED WATER	13
VI. TECHNOLOGY OF ENAMELLING	15
Pulverising, grinding, washing, acidulation, and preservation of enamels—Description of the grinding of enamels and the operations con- nected therewith—Principal metals suitable for enamelling—Preparing the metals—Counter- enamelling.	
VII. THE ART OF THE ENAMELLER	41
Champlevé surfaces—Chased and repousse surfaces —Shaped articles—Cloisonné—“À jour” or trans- lucid enamels—Plaques—Standard samples and range of colours.	

CONTENTS

CHAPTER	PAGE
VIII. ENGINE TURNING	73
IX. PAILLONS AND THEIR APPLICATION	75
X. MATTING THE ENAMELS	80
XI. FILING AND POLISHING THE ENAMEL	81
XII. HARDENING AND SOFTENING OF ENAMELS	84
XIII. REPAIRS	86
XIV. PICKLING—CLEANING THE METAL AFTER ENAMELLING	90
XV. GILDING, PLATING, AND COLOURING ENAMELLED ARTICLES (CONSIDERATION RELATIVE TO THESE OPERATIONS)	91

PART II**PAINTING ON ENAMEL**

A RÉSUMÉ OF THE PRINCIPAL PROCESSES	93
---	----

ENAMELLING ON METAL AND PAINTING ON ENAMEL

PART I ENAMELLING ON METAL CHAPTER I

DEFINITION AND CLASSIFICATION OF ENAMELS

IN the particular sense in which it is understood in this manual, enamel is a vitrifiable substance capable of adhering to, and ornamenting certain metals.

Enamels are classified in the following manner :—

A. **Translucid Enamels** are very pale, through which light can pass without difficulty. In this category are included the **Fluxes**, which are generally colourless or only faintly tinted.

B. **Transparent Enamels**, through which light passes more or less readily, accordingly as they are classed light, medium, or dark. In this category may be placed the **Opalescent Enamels**, of which the transparency is, in varying degrees, clouded by a milky veil, which confers on them a strange and delicate charm.

C. **Opaque Enamels**, of a solid and compact substance, through which light does not pass, being only reflected from the surface.

With regard to this summary classification, we may say that although the definitions concerning the first two categories do not correspond with those generally found in modern dictionaries, we have adopted them in this work for the sake of clearness ; they have been hallowed by long usage in the language of the craft.

This point being determined, we mention also, that enamels of all categories are variously coloured, comprising the primary and secondary colours, and an infinite variety of intermediate and fancy tints. In view of the similar nature of their bases, enamels may be mixed together for use, but they are liable to the effects of chemical reactions under the influence of heat, it is therefore better to superimpose one or more coats of varying colours to obtain the required tints rather than to mix the enamels together.

CHAPTER II

WORKSHOPS

It is preferable to choose a workshop comprising three distinct apartments communicating with each other, and comprising :

1st. **The Enamelling Shop.**—A well-lighted and dry room without curtains or draperies and free from dust, this latter condition being indispensable to secure the success of the work.

2nd. **First Laboratory.**—For all work of pickling, polishing, scouring and other similar operations. This room should be suitably lighted and also free from dust. If more convenient one room will serve for the above purposes if simply divided by a glass partition or thin wall.

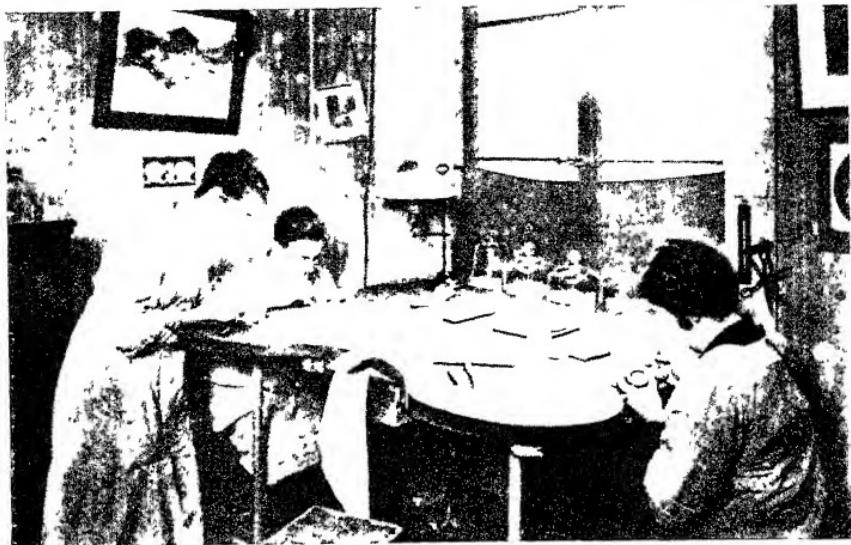
3rd. **Second Laboratory.**—Containing one or more furnaces, and which can be used for various manipulations where cleanliness is not so essential : for storing fuel, etc. For this purpose a rather dark room is perfectly convenient, as a diffused light in the section of the furnaces shows up more distinctly the tonality and heat of the interior of the muffle, an exact judgment of which affords the best and surest guide for firing. This room should be provided with a good chimney-flue assuring at all times a perfect, irreproachable

ENAMELLING ON METAL

draught, a good water supply, and an efficient supply of gas if the furnace or furnaces are heated by this means.

There should also be a sink or other contrivance "ad hoc" for pouring away the waters used in pickling, and other liquids.

PLATE I



Enamelling shop



Enamelling a plane surface with a
“point”



Drying out the enamel with a linen
rag



Grinding bench Nest of drawers
for the enamels



Enamelling a shaped article with a
brush

CHAPTER III

FURNITURE AND TOOLS

ENUMERATION and description of the furniture and various tools, etc., with their distribution, excepting those which will be specially referred to when describing the various operations in successive phases of the work.

1st. The Enamelling Shop.

A semicircular work-bench, provided with drawers, and facing the daylight (see Plate I). On this work-bench are placed the articles in course of execution and the necessary sketches, designs, etc. : the ground enamels contained in glass or china pots, which should be carefully covered by a bell-glass, when not in immediate use : various small tools, comprising small steel "points" and steel spatulas of various forms and sizes for depositing the enamel on the objects or to spread it evenly or smooth it ; soft brushes and stiff brushes of white bristle, one or two pairs of tweezers or corntongs and one or more dropping bottles containing filtered water ; such other accessories as may be found necessary.

A work-bench or table (see Plate I), on which to grind the enamels ; of varying form, but at any rate

a piece of furniture of which the top should be of hard wood, of from 3 to 5 cm. thick, borne on solid legs of hard wood or iron, fixed to the floor. The construction of this piece of furniture in accordance with these instructions is not without importance. This work-bench must be reserved for the grinding and washing of the enamels ; on it will therefore be placed the mortars and pestles of agate or hard porcelain, one or two wood mallets, the acids, and all the other accessories needed for this delicate operation.

This room contains also seats, and, optionally, other work-benches, cupboards in which to keep the work in course of execution, the small tools and other accessories according to requirements.

2nd. First Laboratory.

Table for pickling of pine wood, with various utensils such as copper pans about 15 cm. diam. and 5 mm. thick, china or stoneware pans or dishes, hard brushes of bristle. One or more polishing lathes, with wood, emery, and felt-covered chucks. Filing bench in pinewood—with a raised beading round three sides—the top covered with zinc, provided with a drawer, over which will be fixed a peg, as in a jeweller's bench, as a support for the work while being filed or stoned. An assortment of emery sticks or other abrasives : of various degrees of "grit."

Polishing bench, also in pine fitted as the above.

Polishing leather and powders, round wooden pegs with wax ends.

Sink with water supply (see Plate IV).

This workshop will also contain the necessary seats, cupboards, etc.

3rd. Second Laboratory.

One or more furnaces with chimney and damper, large tongs (one or two kinds), also if necessary a box or other receptacle, with divisions, for the fuel ; seats, cupboards, etc.

CHAPTER IV

FURNACES AND THEIR ACCESSORIES

THE choice of a furnace is of great importance, and the selection of the system of heating will depend upon various circumstances, according to the locality of the workshop and also according to the nature of the work to be fired.

Four principal systems of heating are now in use. Coke furnace ; gas-heated furnace (ordinary house gas) ; petrol or benzine furnace ; electric furnace (see Plate II) Only the first three require a chimney for the escape of the waste products of combustion.

Each type varies in its construction, but consists generally of two essential parts, viz. the body of the furnace, carrying in its interior the muffle of fire-clay in which the articles are fired.

We will pass rapidly under review these various systems, and examine what are their advantages and their respective drawbacks.

A. Coke-Furnace.

This is the ancient and classic system, generally speaking the most economical as regards fuel, wherefore it is preferred in those workshops where the firing is continuous. By its means a high temperature can

be obtained, assuring a brisk, sharp firing which favours the even flow and limpidity of the enamels.

A furnace of this type, however, is naturally heavy and cumbersome, and requires a base of light masonry, and its maintenance is relatively troublesome, having little to recommend it to beginners or amateurs. Moreover, this type of furnace creates a good deal of dust, very unfavourable to the enamels, and requires constant attention to the stoking and the regulation of the draught, while considerable time is required to bring it up to firing heat, and further, coke has the very serious disadvantage of rapidly burning out the muffle and impairing the condition of the body of the furnace, necessitating frequent repairs and putting it out of use in a few years.

As to the quality of the coke, a medium hard sort is to be recommended.

B. Gas-heated Furnace.

This type is at the present time in very general use, on account of its light weight and reduced size, being generally mounted on iron feet. This furnace may be simply placed on a wooden table, the top of which has been covered with thin sheet iron.

Such a furnace is very lasting, and rarely requires the muffle to be replaced; it is quickly brought up to firing heat, easily regulated, creates no dust, and is really the most reliable apparatus, provided of course that gas can be obtained and that its price is not too high. The quantity of gas used is naturally dependent on the size of the burner, which in turn depends on the size of the muffle and the degree of heat required for normal fusion of the enamels. The

regulation of the burner has further an important part to play, both as regards the expense of the gas and the degree of heat attained, and it is indispensable that the meter and service pipes should be of sufficient capacity to provide the necessary pressure for the efficient heating of the furnace.

C. Petrol-heated Furnace.

Recently introduced, this type of apparatus enjoys a certain favour, especially in the trade, on account of its relatively low cost in comparison with other systems. It is highly appreciated, particularly in localities where illuminating gas cannot be obtained. It is generally mounted on high iron feet. It is light, not cumbersome, easily moved, durable, and does not burn out the muffle ; is rapidly brought to firing heat and easy to regulate.

Neat furnaces of this type, free from smell or danger, are supplied by the trade.

D. Electric Furnace.

This is the ideal apparatus of an exquisite precision and, to our mind, the furnace of the future, having in view its small size, faultless cleanliness, and the mathematical accuracy with which it can be regulated by means of a pyrometer. Provided with a resistance fixed on a graduated wooden scale, firing heat is obtained in a few minutes with perfect regularity.

It has the great advantage of safeguarding the enamels from all risks of chemical reactions or other troubles arising from the faulty or imperfect combustion of gases which sometimes occur in other types

of furnace. It requires no flue or special position. It attains high temperatures which remain uniformly equal in all parts of the muffle.

On their first introduction these furnaces were in very small demand on account of their very high price due to the use of platinum in the resistances; but their cost has latterly been reduced owing to the introduction of interchangeable resistances and the use of less costly metals.

There are at present on the market various types of well-constructed and practical furnaces at a relatively moderate price.

We repeat that this would appear to be the system of the future, if only circumstances will permit of such a further reduction in cost as will bring them within the range of commercial use.

Whatever system be adopted it is advisable to fix in front of the muffle opening a ledge of metal, the width of the furnace, projecting about 20 to 25 cm., sufficiently strong to bear the objects to be fired, in order to expose them to the heat of the muffle—firstly to dry them, and further to accustom them gradually to the intense heat.

Principal Accessories of the Furnace.

In the muffle should be placed permanently a small circular and slightly convex support of fire-clay on which the "planche" bearing the article to be fired can rest and be turned easily. Further, an assortment of planches of various sizes, round, square, and rectangular, as may be required. These planches are plates of special fire-clay from 2 to 4 mm. thick, and should previous to use be smeared with a thin coating

of ochre and water and allowed to dry in the open air, this coating is intended to prevent any articles which are "counter enamelled" from adhering to the planche during firing, the articles being placed on these planches previous to the drying operation, remaining undisturbed thereon until the firing is completed. Round planches can be obtained to order having a slight concavity in the centre, fitting the convex form of the support, thus permitting the planches to be turned readily by means of the tongs without jolting or displacement. A pair of long tongs from 60 cm. to 1 metre or longer according to the size of the furnace. They must be of forged iron or steel, strong, though light and flexible, and should be provided midway in their length with a nut and wing screw for adjusting the opening of the tongs, thus facilitating the grasping of the planches.

[*Translator's Note*.—The illustration on Plate II shows a pair of spring-end tongs and illustrates the necessity of a nut and screw to adjust the maximum opening of the jaws.]

Further, one or two pairs of steel corntongs of from 15 to 20 cm. in length, which are useful for manipulating the planches bearing the articles on their introduction as well as their extraction from the furnace.

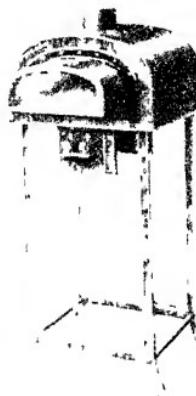
These accessories will generally be found sufficient for the work of firing, but others may be added according to special requirements.



Firing Coke furnace (left), gas furnace (right)



Pulverising enamel



Petrol furnace



Electric furnace



Grinding enamel



Range of coke furnaces w
interchangeable muffle

[To face p

CHAPTER V

ACIDS AND FILTERED WATER

THE acids commonly used are :

Pure nitric acid (1420°), sulphuric acid (oil of vitrol), stick caustic potash (this latter to be kept in hermetically sealed jars).

The acids also must be kept in narrow-necked glass bottles provided with glass stoppers, ground to fit accurately. As an additional precaution these bottles should be kept in a safe place, away from any heat or contact with metal parts which would risk being oxidised by their fumes.

Moreover, it is indispensable to have constantly at disposal a sufficient quantity of filtered water even if the water supply is considered to be pure. The trade supplies numerous types of filters ; those fitted with tubes of porous porcelain are handy and not very cumbersome and can easily be fitted to the existing water service.

But in most workshops suitable filtered water can be obtained by pouring ordinary water into a glass funnel, into the neck of which has been inserted a small piece of very fine sponge, which will pick up on their passage any impurities held in suspension in the water, the filtered water falling drop by drop into

a bottle or decanter provided with a polished glass stopper.

Filter papers or other fibrous substances must not be used, as they let fall innumerable fragments prejudicial to the enamel.

We may now close our brief description of the workshops and material; but we will refer to some points and deal with certain articles and substances not yet examined, as and when these come under our view, in describing the various manipulations.

CHAPTER VI

THE TECHNICS OF ENAMELLING

Selection and preparation of the enamels, and their principal applications. Firing and further manipulation, etc.

The composition of the enameller's pallet, that is to say, the selection of the range of enamels, is a question of the utmost importance, as from it will result the success of the work, or, on the other hand, costly failure. Well-conceived designs may frequently be marred both artistically and commercially by the employment of ill-chosen or unsatisfactory material, due either to lack of forethought or false notions of economy.

It is therefore indispensable to procure enamels with which it is possible to work in full security, especially in view of the phenomena of expansion and contraction—those of homogeneous composition and reasonably uniform fusibility, briefly, such as are capable of being mixed together or superimposed one on another without the risk of fracture or cracking—which would inevitably consign the articles to the scrap-box.

Information on these points will willingly be given by the author of this work, himself at the head of an old-established firm of world-wide reputation, which

through many generations has produced enamels of the highest quality, ranging from the ancient, one might say classic, colours, to all the ultra modern shades, and whose well-proven range, extensive as it is, is constantly being extended by the addition of new tints whose working properties conform in every respect to the condition mentioned above.

Generally speaking, all enamels should be capable of adhering to the principal metals, gold, silver, copper, and their alloys and derivatives.

Nevertheless, a careful selection should always be made, keeping in view the nature of the metal which it is proposed to enamel.

After the receipt and checking of the enamels, it will be well to pack each tint separately in a well-closed box or jar, to avoid any possibility of their getting mixed together, and each container should be distinctly marked with the title under which each enamel has been invoiced (a nest of drawers will serve equally well for storage).

Pulverising, Grinding, Washing, Acidulation, and Preservation of the Enamels.

Many firms at the present time undertake to supply enamels ready ground, but as the machinery and processes employed may be of doubtful value and there are also the possibilities of fraud and adulteration, we are of opinion that only a firm of the highest repute can guarantee the proper and conscientious execution of this delicate operation.

Ready-ground enamels may be of service, but only in cases where considerable quantities are required for commercial work, where quantity rather than

quality is the prime consideration. A considerable saving of time can then be effected, but even then the various processes hereinafter described, namely, regrinding to equalise the grain of the enamel, numerous preliminary washings, acidulation, and the subsequent washings must on no account be omitted.

Nor should ready-ground enamels be employed under any circumstances, when careful work on a comparatively small scale and entailing the use of several colours is to be undertaken.

It is therefore preferable to procure the enamels in lumps or cakes. The large pieces can easily be broken up, by wrapping them in a piece of clean linen, holding them in the hollow of the hand, then a few sharp blows with a suitable hammer will quickly reduce them to pieces the size of a small nut, and all the small fragments can be utilised.

With regard to grinding by hand, the choice of a suitable mortar is of great importance for the successful completion of this very delicate operation.

It is essential, or most decidedly preferable, to use an agate mortar and pestle, or alternatively one of hard unglazed porcelain, but this latter only from motives of strict economy.

An agate mortar is the ideal—it does not scale or grind away, and given rational use is practically indestructible; on the other hand, a mortar of hard porcelain is subject to a certain amount of wear every time it is used, and should therefore only be used in a case of absolute necessity or for completing the grinding and washing of enamels already mechanically ground, or to facilitate the washing of considerable quantities of enamel already ground in an agate mortar.

Description of the Grinding of Enamels and the Operations connected therewith.

The grinding will take place in the enamelling shop on the bench or table for that purpose, and we must not lose sight of the fact that on this delicate operation will depend in large measure the perfect condition of the enamels after firing.

The mortar should be placed on the work-bench over one of the supports, so as to secure a perfectly firm base.

Between the table top and the mortar should be placed a clean cloth folded square like a pocket handkerchief, so as to absorb the shocks of the pestle in the mortar. The pestle should be firmly fitted for about two-thirds of its length in a handle of hard wood, provided with a metal ferrule and with a rounded butt; a little mallet of hard wood with a slightly flexible handle should be provided (the use of a metal hammer must be absolutely interdicted); there must also be at hand a bottle or decanter of filtered water, the only water to be used throughout this operation, an earthenware jar or such like, to receive the muddy water and silt which will eventually be washed out of the enamel.

Proceed as follows: Place in the mortar a certain quantity of the enamel broken as already described, but not too much at a time, and fill the mortar to about two-thirds of its depth with water. The pestle, held lightly but steadily in the left hand, is then placed vertically over the enamel and a few short sharp blows are given with the mallet on the end of the handle of the pestle (see Plate II); after a few minutes of

this, the water will become troubled and the enamel reduced to smallish granules; practically the whole of the troubled water must now be poured away, and if it is seen that there are still any fairly large fragments of enamel in the mortar, it is easy to break them down by pressing firmly on them with the pestle, giving it at the same time a rocking motion.

This done, and the enamel being roughly reduced, a few drops of water are added to facilitate the grinding which is to follow on immediately, and to ensure the regularity of the grain of the enamel—a most important matter.

Therefore the wooden handle of the pestle is then firmly held in the right hand, but not stiffly, and a circular motion is described in the bowl of the mortar sufficiently rapidly to stir up the whole of the enamel and grind it to the required fineness (see Plate II); if during this grinding the enamel becomes pasty, add a little water. At the beginning of this operation a certain amount of pressure should be exercised, but this pressure must be gradually reduced, to ensure a perfect regularity of grain, and also to avoid the formation of an excess of the *silt*, a kind of light and cloudy dross which is developed from the enamel in the course of grinding. From time to time a swift circular movement must be given to the mortar so that the water may sweep back any particles of enamel which may adhere to the upper part of the mortar and thus escape the action of the pestle.

After about five or six minutes or more, according to the quantity being ground, the enamel must be washed with several waters, to free it entirely from silt. To effect this the mortar is filled to within about

half an inch of its rim, then with the pestle the mass of enamel which has settled in the bottom of the mortar is gently stirred in a circular direction for about a minute; then the heavier portion of sound enamel is allowed to settle, to facilitate which it is advisable when the stirring has ceased to hold the mortar in the left hand, while with the right little sharp snappy blows are struck on the edge of the mortar with the butt end of the pestle (never with the agate end) or the wooden mallet may be used for this purpose.

Under this action the enamel tends to precipitate; the supernatant water charged with the waste or silt must be absolutely eliminated by pouring the whole of the sullied water into the receptacle provided for that purpose.

To eliminate entirely the silt, it is inadvisable to wait more than two or three minutes after the first washing, otherwise it may sink back to a greater or less degree into the clean enamel: which would render the washing useless, as its sole object is to effect the entire removal of the silt.

Nevertheless the water must not be poured off too quickly, or a notable part of the sound enamel might be carried away as well.

This operation of washing must be repeated five or six times, according to the quantity of enamel ground, until the supernatant water is absolutely free of silt and presents a clear and potable appearance. With each succeeding washing the enamel will precipitate more and more quickly, and it is therefore necessary to be careful to pour away the water at the right moment, certainly before the faint traces of silt remaining have the chance to settle. These

various preliminary operations, it must be remembered, only serve for a first summary grinding, which is insufficient to bring the enamel to the required fineness of grain, so a second and third period of grinding must be gone through, each followed in its turn by a series of washings as already described.

These alternate washings and grindings are not without reason, and the final result would be very inferior in every respect if in order to save time one confined oneself to one grinding only, even if this were followed by many washings.

After the third and final grinding, the enamel should have the appearance of a very fine sand with perfectly regular grain ; on the other hand, it is highly important that the enamel should not be ground to excess, except in certain very special cases ; translucent and transparent colours, and especially the reds, of this latter category must be of a moderately coarse though perfectly regular grain.

With regard to these latter enamels, an excessive grinding would be very detrimental, marring especially the brilliant limpidity which they should present after firing. On the other hand, opaque enamels, and especially the whites, are improved by fine grinding, gaining solidity and resisting better the operation of "fluxing".

Then succeed, always with the greatest care, the customary washings which follow immediately on the third grinding. When the water covering the enamel is perfectly clean, it is poured away by means of a brisk jerk, the whole of the water should be eliminated, leaving the enamel in a pasty state in the bottom of the mortar.

The acidulation must then be proceeded with in the following manner :—

About eight or ten drops of pure nitric acid are poured on to the enamel while still in the mortar, and the whole is stirred with the usual circular movement with the pestle for from three to five minutes, but very gently and without pressure, to avoid further grinding and the risk of forming fresh silt. Immediately after, to prevent too prolonged action of the acid, it must be totally removed by a series of six or eight washings, applied as before.

The enamel is now in a fit state for use, and should be transferred to one of the glass or china pots, carefully labelled and filled to three-quarters of its depth with water : the various enamels thus ground are now at the disposal of the enameller, and when placed on the work-bench in the enamelling shop should be carefully covered with a bell-glass. It is useful to know that the acid plays a triple part :

1st. It dissolves any metallic particles which have not been assimilated in the body of the enamel.

2nd. It dissolves any free alkalies that may have been disengaged during the process of grinding.

3rd. It destroys any organic matter, such as minute particles of dust which may accidentally be held in suspension in the water.

It is also important to know that the acid tends to harden the enamels, and that in direct ratio to their fusibility ; it is for that reason that it is unwise to leave the ground enamels too long in contact with the acid, bearing in mind the limits already prescribed, except in particular cases where it is specially desired to harden the enamel.

One can, but only with a view to save time, dispense with the process of acidulation, but that omission is only permissible in the case of certain light transparent colours, translucid colours, and certain fluxes. In that case they must be employed immediately after the last washing; remembering also that the purity of their tints may be impaired, for which reason it is generally advisable to acidulate every enamel which is to be used for a choice piece of work in which the limpidity of its tints are essential.

The proportions of acid previously mentioned are generally suitable to most enamels, bearing always in mind the indications given above as to its effects. A few further remarks on the subject arising from these instructions may usefully be given.

To avoid a detrimental hardening, acidulation will be omitted, or reduced to a minimum (three to five drops of acid), for all enamels indicated as extra soft, and the same applies to enamels which have been found by experience to be readily fusible. On the other hand, contact with the acid will be prolonged (five to ten minutes) in the case of certain transparent enamels, such as dark greens, dark browns, and also opaque enamels such as blacks or dark greens.

Moreover, one remark applies especially to transparent reds. One may frequently observe on grinding these enamels, especially the darker shades, the presence of numerous tiny specks of gold, quite visible to the naked eye, which arise from an unassimilated excess of the precious metal from which their coloration is derived.

If the numerous successive washings have not removed the greater number of these specks it is

advisable to dissolve them, as otherwise they will mar the fired surface with little metallic spots, either bright or dark, in a most unpleasant manner.

To remove these spots, the acidulation is proceeded with in the usual manner, but instead of nitric acid, which alone would not effect their solution, a mixture named aqua regia is employed. This mixture is composed of :

3 parts of pure hydrochloric acid (spirits of salts)
1 part of nitric acid (aqua fortis).

Well covered with water and undisturbed, enamels can be preserved in fairly good condition and for a tolerably lengthy period—weeks if necessary ; but nevertheless, enamels freshly ground and washed will always give better results than if kept for any length of time, consequently it is preferable to prepare the enamels as and when they are required for immediate use, so far as that is practicable. It must be remembered that water, even when filtered, acts upon the enamel when it is ground to some extent, and that in proportion to its fusibility, the composition of the enamel is gradually modified, and it loses an appreciable quantity of its basic salts, which results in a certain efflorescence on the surface—a whitish mass, which must be thoroughly eliminated by repeated washings. Thus, every day, before work is started, the enamels in the pots must be refreshed ; for that purpose, the water in the pots is thrown away by giving a sharp jerky movement, then the pot is three parts refilled with filtered water which is poured on to the enamel with some force by means of one of the dropping bottles, so as to stir up the mass. The enamel will quickly settle into the bottom of the

pot; then, before the whitish matter has also time to resettle, that must be poured away. This operation must be repeated five or six times, when the enamel is once more fit for use. If there is only a small quantity of enamel in the pot, the operation can be more readily performed by stirring with a glass rod: further, every third or fourth day, the enamel must be refreshed even more effectually. To attain this, the enamel is replaced in the mortar, washed in several waters and then acidulated, but with a few drops of acid only; then, having stirred the whole with the pestle, but without pressure, for two or three minutes, it is again washed with many waters and is once more fit for use.

Finally, it must be repeated with emphasis, that the delicate operations of grinding and washing exercise a considerable influence on the successful firing and the limpidity of the enamels.

Neglect in these operations will lead to many grievous consequences: muddy or tarnished enamels, pinholes, cracks, bubbles, etc., etc.

Principal Metals suitable for Enamelling.

At the present day, the principal metals used for enamelling are:

Gold, silver, copper, and the many combinations of these metals termed alloys, also occasionally platinum.

To complete the survey, we will also examine some other metals of less frequent use.

It may be laid down as a general rule, that the higher the standard of purity of the gold, silver, or copper, that is to say, the nearer they approach to

absolute fineness, the better are the results they produce both as regards the limpidity and true colour of the enamels.

However, referring to gold and silver, their standards vary greatly, and for industrial purposes they are hardly ever used in a pure state, for the reason that, owing to the softness of the metals, they would not offer sufficient regidity for the manufacture of articles destined to be handled, chased or worked in other ways ; further, such articles would be seriously distorted during the process of enamelling. It is therefore mostly in the form of extremely thin sheets ("paillons" or foil) that these precious metals are used in a pure state, that is to say, their utmost degree of fineness, 24 carats for gold and 1·000 for silver, when the metals are then named "virgin." These excepted, the highest "standards" are 18 carats for gold and 0·950 for silver.

With reference to copper, which has sufficient resistance in itself, it is advisable to use it in the utmost state of purity obtainable ; remarkable results can then be obtained on it, whilst the admixture of any base metals may be disastrous both as regards the adherence of the enamels to the metal, and the beauty of the colours.

Pure gold, silver, and copper can form between themselves various alloys, and it is clear that the natural colours of each of these metals will influence and modify profoundly the proper tints of the various enamels used for their decoration.

For instance, an alloy of gold and copper, in which the latter predominates as in gold of 9 or 10 carats, is called red gold. Green gold is an alloy of gold and

silver in about equal proportion. An alloy in which silver has a marked influence is called white gold, this alloy is produced mainly in 14 and 17 carats

[*Translator's note.*—The standards quoted by the author are Continental ones. The highest English standard for gold being 22 carats (sovereign gold) and 0·925 for silver ("standard silver").]

Silver is used in varying standards, rarely at 1·000, but currently at 0·950, 0·935, 0·900, 0·850, and also, but rarely 0·800.

[*Translutor's note.*—Here again the author is quoting Continental standards, the only recognised English standard being 0·925.]

Under the name of platinised-silver, an alloy of approximately 0·950 part of fine silver and 50 parts of platinum is sometimes employed for enamelling, the object being to render the silver harder and stiffer. From this it will be seen that the noble metals are susceptible of forming an infinite variety of alloys to meet various requirements, and also that there are many "standards" which may not, in fact do not, always correspond in different countries. It must be added, while on the subject of alloys, that all too often metals are employed absolutely unsuitable and leading to fatal results, not only as to the clearness and purity of tint of the enamel, but as to its actual adherence to the metal.

We cannot but consider that modern metallo-chemistry is not only very ignorant but very prejudiced and conservative, giving but scant attention to this subject and ignoring the paramount importance of the part played by the composition of any alloy intended for enamelling. A little judicious thought

on the part of our refiners brought to bear on the preparation of the metals intended for enamelling would in many cases save both manufacturers and enamellers from costly failures. An energetic protest must be entered against the practice of employing as alloys base metals which are injurious to enamels, such as zinc, tin, or antimony. In the eyes of many refiners, any waste metals without exception seem fit for this purpose, and this we repeat is a very grave error.

Pure platinum is rarely used for enamelling, firstly on account of its high price, but mainly because of the serious risk of the enamel not adhering ; in this respect it is very freakish, and the chances are nine to one against the enamel holding. Their respective ratio of expansion and contraction seem literally opposed. It has been suggested that the structure and form of the article, by setting up some peculiar physical or mechanical action, might influence the adhesion or non-adhesion of the enamel to this metal ; but up to now no definite rule has been formulated, and it would appear that the more readily fusible enamels will give the best results. Further, a close or criss-crossed pattern of engine-turning will help the adherence of the enamel, and it is also wise to avoid a too sudden change of temperature when the "fired" article is withdrawn from the muffle ; this might cause an immediate breaking away of the enamel, or the enamel might hold until the work is practically completed and then fly (as it is termed), which is still more disastrous ; great prudence is therefore recommended.

Nickel can also be enamelled, as well as certain

base metals derived from copper, such as tombac, gilding metal, bronze, etc., but their employment is always attended with risk as to the adherence of the enamel, and in any case they are only employed in the manufacture of cheap commercial articles, such as buttons, badges, door plates, furniture fittings, etc., opaque enamels being mostly used, as these give generally more satisfactory results than the transparent varieties.

For the enamelling of these base metals, the same processes are to be followed as for copper, and readily fusible enamels should be employed by preference. We may further mention that these base metals can be enamelled with, in every respect, greater success when the surfaces which it is proposed to enamel have been covered with a strong coating of copper by an electroplating process; this plated surface to be treated in the same way as copper.

It is also possible to enamel "rolled" metals, that is to say, a base metal, usually copper, to which is intimately attached a sheet of one of the noble metals either pure or of a high standard, but care must be taken that this "rolled" metal is well tested, so the two metals do not part company under the influence of the firing. Here also it is advisable to employ very fusible enamels.

It is also permissible to engrave or engine-turn "rolled" metals, on condition that the noble metal is of sufficient thickness; the depth of the cut should not exceed two-thirds of this.

Iron is also enamelled, in the form of plates, watch-cases, etc., but should not be "pickled" in the usual acid bath; it will be sufficient to clean it and at the

same time roughen the surface with a file or coarse emery paper ; this in all its smallest recesses making it perfectly bright. This operation, which takes the place of "pickling," should be performed immediately before the enamelling to avoid risk of any further oxidation between the two operations. Immediately before applying the enamel, the article should be rapidly cleaned with pure alcohol to remove any grease, then warmed gently before the muffle, and as soon as cool the enamels can be applied ; these are always opaque, and usually limited to a few tints.

Preparing the Metals (*Le Decapage*).

We will now describe the "preparing" of the various metals, which operation has the effect of removing the film of oxide, of greater or less thickness, which forms on their surfaces, and no trace of which must remain, under penalty of jeopardising the success of the work. One must, therefore, always bear in mind the imperative necessity of preparing immediately before applying the enamels, to avoid the formation of any fresh coating of oxide, which might occur between the two operations (exception may be made of the noble metals, gold, silver, and platinum in the virgin state, as, not being susceptible to oxidation, preparing may be dispensed with).

[*Translator's note.*—The word "decapage," for which there is no English equivalent, and which means in its more limited sense the removal of rust, verdigris, etc., from brass and such like articles, is employed by the author to indicate the whole process of preparing metals for enamelling ; and the term "preparing" is used by the translator to indicate the

same process in its entirety. The treatment of metals in a bath of dilute acid is referred to by the translator as "pickling" or "boiling-out" and the acid bath itself as "pickle" (the accepted trade terms)]

The composition of the pickling bath may vary according to the practice of the craftsman, as also according to the nature of the metal or the articles to be treated.

There are two average formulas suitable for two classes of metals :—

Gold, platinum, copper, and their alloys, etc., but not silver.

80 to 100 drops of sulphuric acid (oil of vitriol)
in 1 litre (about $1\frac{1}{4}$ pints) of water.

Silver and its alloys.

50 to 60 drops of sulphuric acid in 1 litre of water.

The pickles should be kept ready for use in an earthenware or hard porcelain bath, and care should be taken to mix the two liquids with a wooden spatula or glass rod ; it can be used either cold or lukewarm. As, however, the pickle gradually loses its action it must be strengthened from time to time by the addition of a few drops of acid.

The process of "preparing" is as follows :—

The furnace having been brought to normal working heat, the article, or several if convenient, is placed on one of the fire-clay planches and by means of the furnace tongs introduced into the muffle ; then, resting the planche on the little support contained in the muffle, it is gently turned by means of the tongs so that the article becomes uniformly heated ; this must not exceed dull red for articles to be decorated with

transparent colours, while it is preferable to attain a cherry red if opaque enamels are to be used.

When the desired heat has been attained the article is withdrawn from the furnace and dropped into the pickle bath while still warm, remaining there about fifteen minutes or longer if more prolonged action is required.

For articles in gold or silver the pickle is poured into a copper pan, the articles placed therein, and the pan held before the furnace mouth until the pickle boils. The articles are withdrawn from the bath by means of a wooden spatule or small pair of tongs, taking great care not to get any of the liquid on to the fingers, the article is then thoroughly washed in running water to remove all trace of acid. It is then carefully brushed in all its least recesses or convolutions, with a brush of very hard bristles and fine powdered pumice mixed with water to a thick paste, not only to remove any grease, but also to brighten the surface.

For articles in gold or silver of a high standard a vigorous brushing with water only will be sufficient.

When the brushing is finished the article must only be handled with absolutely clean fingers, and contact with any material that might tend to grease or tarnish the surface must be avoided.

So, as soon as the article has been thoroughly brushed, it must be well rinsed in running water, being held in a pair of small tongs, or even by the fingers providing these do not touch any parts that are to be enamelled. After that it must be wiped quite dry with a linen cloth; an old or worn piece will be quite suitable, but in either case it must be scrupulously clean. Finally the article is once more placed

on the fire-clay planche, as at the beginning of the operation, and is then allowed to rest before the mouth of the furnace—never within it—turning the planche slowly for a few minutes so that every part of the article is equally exposed to the heat ; it is then withdrawn with the tongs, and as soon as cold, the enamelling properly so called must be proceeded with at once, to avoid any oxidation or the contact of grease or dust.

But before describing the process of enamelling we will once more refer briefly to the question of pickling and drying, to be quite clear on certain points of this process.

As we have already said, the noble metals, gold, silver, and platinum, in their virgin state do not require pickling ; it is sufficient to heat the article to dull red in the furnace, when it is at working heat, and to proceed with the enamelling as soon as it has cooled. In many workshops, articles of silver of 1 000 fine or thereabouts are enamelled without pickling. But this only applies to articles engraved or engine turned where the bright cuts of the graver are sufficient to throw up the beauty of the colours : in this case, any grease is removed in a bath of alcohol and the articles gently warmed in the mouth of the furnace.

The more alloy contained in the gold or silver, the greater the care to be taken with the preparing ; for low qualities the process should be repeated two or three times, adding considerably to the strength of the acid (double or treble the quantity). This has the effect of dissolving from the surface of the article a portion of the base metal composing the alloy, and presenting a surface for enamelling in which the noble metal predominates. This is an excellent means of

counteracting the use of unsuitable alloys such as those to which we have made reference.

For copper, the proceeding will be as just described, but it is advisable, when the article is withdrawn from the pickle, to plunge it for a brief moment into a bath of pure nitric acid, then well wash and brush as usual.

While still on the subject of copper, we must warn every worker who desires to obtain on that metal a surface of enamel clear and free from spots, against the deplorable tradition which insists that copper articles should be blued in the furnace, even lightly, before enamelling. This fatal practice is a manifest error, as blueing simply produces a fresh oxidation of the surface, undoing the effects of the "preparing" and producing in the enamel horrible patches which it is impossible to remove, do what one may. Therefore—to be fit for enamelling—copper after "pickling" should only be gently warmed in front of the muffle, preserving its natural tint of salmon-pink. All alloys of copper are to be treated in this manner. Before describing the actual enamelling, it is indispensable to give a few preliminary explanations concerning the rational application of the enamels or the various metals used in this art.

As a general rule any enamel can be used on any of the metals enumerated, although for various reasons—fusibility, or the production of certain shades of colour—it is advisable to make careful selection in order that, according to the composition of the metal in use, enamels may be chosen which will give from every point of view the most favourable results. We may point out here that certain enamels which,

applied in direct contact with the metal, would be subject to a considerable alteration of tint, will give excellent results when a preliminary undercoating of flux is fired on to the metal, thus making a protective film between the metal and the enamel. Various fluxes can be used for this purpose, each being suitable for a different type of metal, and it is the preponderating metal in the alloy which will determine the choice : gold, silver, copper and its derivatives each having their own especial fluxes.

It can be taken as a rule, therefore, that any enamels of known quality, prepared and applied strictly according to the instructions laid down, which give nevertheless unsatisfactory results, such as a deep muddy colour, or seem in any way unfavourably affected by the metal, can be employed with entire success providing the preliminary coating of flux is first applied. We can now, therefore, state a few definite cases, considering the metals in their relation to the enamels, both the transparent (including the translucid) and the opaque.

On virgin gold (24 carats) one can generally apply directly : all the transparent enamels, except greens, opals, deep violets, browns, and dark greys, which require the preliminary undercoating of flux ; and all opaque enamels without exception.

On virgin silver (1·000) can be applied generally : all transparent enamels, except dark greens, opals,* rose,* orange, yellows, dark browns, reds,* and ambers, which require the preliminary coating of flux.

* The success of the particularly delicate colours, marked * depends entirely on the preliminary coating of flux, which must be as thick as possible and very even.

All opaque enamels can be applied directly on virgin silver with the exception of rose, which requires a preliminary coating of soft white, which plays a corresponding part to the flux under the transparent enamels. On green or white gold, one can as a rule apply directly all transparent enamels, except those as already indicated, which require on virgin silver the preliminary coating of flux ; also all opaque enamels without exception.

On red gold, and all golds of low standard, as a general rule, no transparent enamels should be applied directly, all requiring the preliminary coating of flux.

However, certain light transparent colours, such as blues, greens, rose, lilac, turquoise, and certain reds, give fairly good results without the flux.

All opaque enamels, without exception.

On silver of various standards (0·950, 0·935, 0·900, 0·850, 0·800) : as a general rule no transparent enamels should be applied directly.

Nevertheless, a limited range of enamels, certain blues, greens, violets, and lilacs, give tolerably good results without the assistance of flux. One peculiarity can be noted, that on 0·800 silver, reds applied directly give very good results, providing the silver is alloyed solely with pure copper. All opaque enamels can be applied directly, excepting the roses, which require a preliminary coating of soft white.

On platinised silver, the rules for virgin silver apply.

On platinum : all transparent and opaque enamels are applied directly.

On pure copper, as a general rule, no transparent enamels should be applied directly ; all should have the preliminary coating of flux, although certain medium

or light colours, such as blues, greens, roses, violet, lilacs, grey, and particularly reds, give satisfactory results without the aid of flux, though some of them have the tendency to develop a certain sombreness of tint.

All opaque enamels are applied directly.

On base metals, alloys of copper, the rules for copper will be taken as guide, it being always remembered, if any doubts should arise, that it is the predominant metal which must determine the choice of flux.

We have already said that in principle all enamels, either transparent or opaque, can be applied to the various metals just enumerated: all the same, it is frequently advisable to make a carefully thought out selection, being guided by the technical or artistic requirements of each case. For instance, enamels of moderate fusibility or relative hardness will be especially suited to gold of high quality and copper alloys of high resistance, while more fusible enamels will be selected for silver, white gold, platinised silver, and most base metals. Also for special reasons, the transparent reds are manufactured in distinct qualities either for gold, silver, or copper, as are also the whites and blacks.

It remains to be said, that independently of the combinations and reactions, sometimes disastrous, which may occur between the metals and enamels, whence the necessity for the undercoating of flux, the natural colour of each metal has a considerable influence on the resulting colour of the enamel, which it may modify or even alter very strangely, this being the more marked the lighter or more delicate the colour.

This ineradicable property, often a drawback, may, on the other hand, often be turned to good account.

Hence comes the need for judicious selection. To cite a typical case, a light blue enamel which on silver produces a clear sky blue, will give on gold a greyish green of great charm, which will appear still darker and of a very different shade on copper. We may add also that certain greens giving a cold tint on silver, will change considerably, being darker and warmer on gold or copper. According also to the natural colour of the metals the opals are so far modified as to be unrecognisable ; in fact, all enamels, in varying degrees, will present as many shades as the metals in use.

It is easily understood, then, how a careful choice either of the metal or the enamel can procure artistic results, and amplify the range already so rich and varied at the disposal of the modern enameller.

On the other hand, owing to their density and compactness opaque enamels are in no wise, or only very slightly, affected by differences in the colour of the metals.

Counter-Enamelling.

We will now consider the part played by counter-enamelling. To explain its purpose, it must be remembered that under the influence of the relative high temperature required to fuse the enamel on to the metal (temperature ranging from 600° C. to 800° C.), both these materials expand, the latter to a greater extent than the former ; and contract on cooling, the metal again to a greater extent than the enamel. This would produce, particularly on large surfaces of metal, a lack of equilibrium which would show itself either by a serious distortion of the article, or by the fracture, total or partial, of the enamel unless the

precaution had been previously taken of applying an equal coat of enamel to the back of the article, compensating for and nullifying the interactions produced by the expansion and contraction. It is from this property that the operation takes its name of "counter-enamelling," since the metal is as it were imprisoned between two layers of enamel whose movements neutralise one another while at the same time they check the natural action of the metal, which thus, being virtually unable to move in one direction or another, retains its rigidity and form practically unaltered. To convince oneself of these phenomena, it will suffice to enamel a thin flat disc of metal on one side only; on cooling this will become convexed on the side which is enamelled, and the enamel will most probably break away in flakes. On the other hand, if a similar disc has an equal coating of enamel applied to each surface, it will remain flat and the enamel will adhere soundly.

The object of this test is to prove conclusively, both the mechanical effect and the great importance of counter-enamelling when large surfaces of thin metal are to be enamelled, such as plaques, or shaped pieces, vases, cups, etc. When, however, the object consists of metal thick enough to be champ-leveed, that is, where the parts to be enamelled can be cut in by the engraver, counter-enamelling is unnecessary.

To conclude this chapter, we may add that theoretically and logically when an article is to be counter-enamelled the coats of enamel both front and back should be of equal thickness, applied and fired at the same time, and that naturally the same enamel should be employed for both surfaces. In practice,

however, large surfaces can be successfully counter-enamelled with a flux specially prepared for that purpose—providing the total thickness of the counter-enamel is sufficient to compensate for the thickness of the various coats of enamel on the surface of the article.

Finally, on no account should waste enamels or silt be used for counter-enamelling, though this practice is common in some workshops, either from ignorance or a misplaced idea of economy.

PLATE III.



Grinding and polishing lathe Filing bench



Filing with an emery stick



Polishing with a "cabron"



Planishing a "plaqué"



Cloisonné work

CHAPTER VII

THE ART OF THE ENAMELLER

THE object of this chapter will be the study of enamelling in its general lines, the application of, drying and firing the enamels, and will be followed by remarks according to the particular nature of the articles to be decorated, examining one by one the various processes employed at the present time.

The enamelling has to be executed immediately after the process of preparing, for the reasons already given, and in the workshop devoted to this purpose, which must be scrupulously free from dust.

The following description of the time-honoured processes of enamelling is considered from the point of view of an article of plane surface, but it is evident that the same technical principles apply to articles of any form. The article to be enamelled should be supported on a slightly sloping table or any stand which will permit of its free movement, especially if it is an article of "form."

A flat object can simply be placed on a flat board or piece of cardboard, and the ingenuity of the craftsman will speedily devise any special form of support which may be necessary.

While manipulating the article during the succeeding operation it is necessary that the hands should be perfectly clean and that the fingers should not

touch any of the parts to be enamelled : a pair of small corntongs or tweezers will facilitate the handling of the article (see Plate I).

For the actual process, that is to say, the deposition of the enamel on to the surfaces to be decorated, the craftsman will have ready to hand the material already described, consisting of an assortment of steel points, that is to say, delicate flat-spatula, or tiny spoons, barely hollowed out, the ends which serve to pick up and deposit the enamel being 5 to 8 mm. long and 3 to 5 mm. wide : these dimensions can of course be varied or extended as necessary. In front of the workman should be arranged, according to their shades, the pots containing the enamels required for use previously ground and covered with water, within reach must be kept some towels of white linen (not too fine) previously washed—worn linen is perfectly suitable, provided it has been thoroughly washed with plain household soap. Before using the contents of the pots, most of the water must be thrown off by a quick jerky movement, so that the surface of the enamel is barely covered. The pots are then slightly tilted towards the worker by placing a flat rule under them, and the actual work of enamelling can now commence, the articles having been suitably prepared (some craftsmen give small articles a light brushing with a brush of white bristles before enamelling). The classical method still in use, is to pick up a small portion of enamel combined with a minimum quantity of water with the end of the point ; this makes a globule of certain consistency, which is deftly applied to the metal, being spread to the required thickness by means of the point. By careful manipulation of the point in little sharp

movements in all directions the layer of enamel can be equalised, veiling or entirely hiding the metal according to its thickness.

Generally speaking, and particularly with reference to transparent enamels, it is most unadvisable to attempt to apply a thick coating of enamel; on the contrary, it should be applied in two or three successive coats, each coat of course being fired as applied. Nor should any attempt be made to cover a surface rapidly. This would only produce an irregular daub, so to speak, which would not only have a very ugly appearance when fired, but might risk causing the enamel to scale away from the metal.

It is therefore, on the contrary, very important to cover the metal, patiently, with innumerable globules, as previously described, in such a way that these just touch each other, being equalised with the point to make a homogeneous layer of regular thickness. Only manipulative experience can guide the craftsman to the proper proportions of enamel and water which must be taken up each time on the end of the point: too little water will hinder the equal spreading of the enamel, but too much water is equally a disadvantage, as the mass will lack homogeneity, will run and give rise to minute ridges whence the water will escape, leaving parts of the metal bare, necessitating retouching, or as they are called remises. When an excess of water is manifest it must be immediately removed in the following manner: one of the linen towels is applied where the water is in excess only just touching the enamel, and is withdrawn as soon as sufficient water has been absorbed to restore the proper balance (see Plate I).

It has already been explained that the enamel must be equalised by the movements of the point as and when it is deposited on the metal.

When the first coat has been applied, it can be further equalised by shaking the article slightly, or by giving a few gentle taps with the side of the "point" on the edge of the article. This will cause the enamel to run smoothly together. When that is done the enamel must be dried, that is, the water must be absorbed, its task as a vehicle being completed.

To effect this, the linen towel folded flat, very clean and very dry, is applied steadily and firmly over as large a surface of the enamel as possible, being held in place by both hands, but without undue pressure, for a few minutes, when the linen will suck up the major part of the water. The towel must then be lifted carefully starting at one corner, being careful not to do this too soon, or part of the enamel may be lifted up with it, a disastrous result, which may also occur if the towel is damp or soiled, even though the contact, may be maintained for some time.

If after the first application of the towel it is found that there is still a considerable amount of moisture left, a second or third application must be made, being careful each time to refold the towel, so that a perfectly dry portion is applied to the enamel. Some craftsmen, however, prefer to effect the drying by applying the towel to various parts of the edge of the enamel until all the water is sucked out, using the same precaution to apply a dry portion of the towel every time. This done, if the surface of the enamel is of any extent it will probably be rather uneven, and this is the right moment to equalise it, by means of a spatula

of polished steel, flat or slightly curved, as may be advisable, which is passed lightly and steadily to and fro over the enamel, which will be in a somewhat pasty condition, thus smoothing and compressing it.

Large surfaces, either plane or shaped, can if preferred be enamelled by means of a brush, instead of a spatula or point (see Plate I); in this case a small quantity of mucilage must be added to the enamel to prevent it running all over the article; this mucilage can be prepared by soaking quince pip or gum tragacanth (gum dragon) in filtered water. Articles of either large or small size can also be enamelled in a dry state, by sprinkling ground and dried enamel over them through a sieve: this is the dusting process. More rarely the dipping process is employed, the articles being immersed in a bath of enamel, water, and mucilage of a suitable consistency. Both these processes, however, may be considered of a degenerate type and not worth a detailed description.

When mucilage is employed the enamel must be allowed to dry of itself—the final drying being accomplished in front of the muffle, care being taken not to “fire” the enamel until all the water has been evaporated, otherwise blisters would be formed which would break away leaving the metal bare. The enamel having been dried out and if necessary smoothed with a spatula, it should be removed to the furnace room, which must be free from dust and draughts, where the ultimate drying, before the article is fired, is to be accomplished.

To effect this, the article is placed on the centre of one of the fire-clay planches; this by the aid of a small

pair of tongs is placed on the metal table which extends from the mouth of the furnace.

From then on care must be taken that the enamelled article receives no jerk or shock, as at this stage the enamel has very little adherence to the metal and any mishandling might cause it to fall off.

It will be understood that by this time the furnace, with closed door, has been brought up to working point, and the muffle, when the door is removed, should show a uniform bright orange heat. Well within the muffle should be the little permanent fire-clay support, on which the planche will rest, and on which it can revolve freely without touching either the sides or back of the muffle.

The planche on which the article to be fired is resting must first be placed on the projecting metal stand, as far from the mouth of the muffle as possible : it will remain here for from five to ten minutes, being turned from time to time so that every part of the article is subjected to the heat from the furnace, thus drying out every particle of moisture.

At intervals of about three minutes the planche must be moved nearer to the opening, turning it as mentioned above, and in about twenty minutes the article will be ready for the very delicate operation of firing on which will depend, in great measure, the success or failure of the work.

A few words of advice may not be out of place here. We have already said, and we repeat with emphasis, that it is essential that the furnace should be at its maximum heat at the moment of firing : and every enameller should take this axiom to heart : *a short firing in a brisk heat.*

On the strict fulfilment of this condition will depend the limpidity and general beauty of the enamels, particularly the transparent colours. A prolonged firing in a dull, dead furnace, to use the time-honoured expression—even if eventually the enamel takes a sufficient glaze—is very detrimental, the colours will be dull and tarnished, and the enamel itself will be full of minute bubbles, while the surface will be covered with pinholes and blisters.

Having, we trust, driven this point well home we will proceed to describe the firing.

By the aid of a long pair of tongs, the planche on which is the article, now absolutely dry, is introduced into the front of the muffle, just far enough that no portion of the article projects beyond the opening, the planche must then be carefully turned two or three times, so that the article may become gradually and equally accustomed to the great heat of the furnace. These preliminaries should not last longer than two or three minutes, or there may be risk of the enamel being partially melted, which must be avoided: then follows the decisive moment of the actual firing, and the whole attention of the craftsman must be concentrated on the article, which must be watched with unremitting vigilance. A good deal of manual dexterity is required in this operation. The planche is placed on the fire-clay support, care being taken that it is central, and then, with eyes carefully fixed on the article, a continuous steady circular movement is given to the planche by means of the tongs, so that the article is heated equally all over—failing this some parts would be less glazed than others.

The time required for firing will vary considerably, depending as it does on the fusibility of the enamels,

the thickness of the metal, the size of the article, etc., but speaking generally after thirty to fifty seconds a change takes place in the appearance of the enamel, which loses its light matt appearance and becomes dark and roughish ; in a few more seconds it brightens and a slight glaze is apparent. Extreme vigilance is now needed, as the glaze necessary for the first coat will develop almost immediately and it is useless and indeed dangerous to push the firing further. If the eye is not sufficiently experienced, there is no particular objection to carefully withdrawing the article from the muffle to examine its condition more closely, and indeed certain craftsmen, in the case of transparent enamels, advise the withdrawal and reintroduction of the article two or three times during a firing, maintaining that it improves the brilliancy of the enamel.

When the necessary glaze is attained, the planche is withdrawn from the muffle and placed on the metal stand of the furnace close to the muffle opening, from which it is gradually withdrawn until the article is cool enough to be picked up by the hand, or by means of a pair of corntongs.

The first coat of enamel, although doubtless somewhat wavy, is sufficiently glazed—developed—to take the second coat, which can be applied immediately or later on, provided it does not get soiled or greased by contact with the fingers or in any other manner, which would necessitate the article being warmed in front of the furnace before applying another coat. If through lack of manipulative skill the first coat is too thin or very unequal, the enamel may burn, to use the professional expression, that is to say, it partially disappears at the thin parts, forming holes of a greater

or less extent, which must be avoided. If this should happen it will be necessary to fill in—remise—these holes before applying the second coat, which must be done with the same enamel. If a virgin metal which does not require pickling has been used, the remising can be done straight away ; but if the metal has originally been pickled, this operation must be repeated, to clean the bare parts of the metal before the remises are applied.

We may mention here, with a view to economy and according to the form and dimensions of the article to be fired, it may be necessary to run two or more furnaces, or in default to have some system of interchangeable muffles. It would be wasteful to run a large furnace to fire a few small pieces, though its use would be quite appropriate for a series of small pieces as well as for large articles.

The shape of the muffle is also a matter for consideration. A long low muffle with the top slightly domed is particularly convenient for articles of a plane surface, such as plaques, brooches, medals, etc.

A taller or violin-shaped muffle is useful for such articles as bonbonieres, puff-boxes, knobs, etc. The spherical or hemispherical muffle of large size, too rarely used in these days, is the most suitable for vases, cups, jardineres, etc., which require a high and perfectly even temperature.

A series of small articles of similar construction, with enamel of uniform fusibility, can readily be fired at the same time, and it is quite feasible to cover two-thirds of a planche with such articles.

On the other hand, if the articles are of different metals or varying constitution, they must be fired

separately, or at any rate a careful selection must be made. Large objects must of necessity be fired separately. It must also be remembered that there exists a definite relationship between the size of the muffle and the article to be fired ; there must never be the risk of any part of the latter touching the side of the muffle, this would not only be detrimental to the proper firing, but might endanger the whole article. There must be room for the article to revolve freely in a sufficient zone of heat, and the space between its extremities and the sides of the muffle should be as equal as possible.

One can also realise the great importance of employing enamels of equal fusibility ; the simultaneous use of fusible and hard enamels would be disastrous, as the former would be burnt out, owing to excess of heat, before the latter had glazed.

We may now continue the description of the enamelling process proper, remembering that a second coat is required, which will be applied in exactly the same way, with the same precaution as the first, care being taken, as already mentioned, that this has not become soiled in any way.

The procedure will be the same for any successive coats that may be required, but whatever the number of these *the last*, be it noted, should have a slightly longer firing than the preceding, so as to develop fully and glaze the entire thickness of the enamel, especially if the smoothness and polish of the surface is to be attained by firing only and not by means of filing and polishing, either by hand or mechanically—processes which will be considered later on.

Furthermore, the surface of the enamel may be

"crowned," or, in other words, covered with a coating of flux, both to protect it and increase its brilliance. In this case the coat of flux is usually polished. It will be well at this stage to make a few remarks with reference to the special firing of certain transparent and translucent enamels, viz. :

The opals are delicate colours, which lose the semi-transparency which forms their charm, and become more or less opaque under the influence of too heavy or even too prolonged a firing. The firing must thus be carefully watched to obviate any excess of heat and to reduce the number of firings to a minimum. On silver the whitish and roseate opals have a tendency to alter and turn yellowish under the influence of too many or too heavy firings. The same remark applies to the red, rose, orange, amber, and yellow. Consequently, if the nature of the work permits, these colours should only be applied at the last fire, if need be in one coat only, equalling in thickness the total thickness of any contiguous colours, although this may seem contrary to the principle of applying the enamel in thin coats.

While on the subject of firing, we may mention that this operation is usually carried out without any particular protection to the eyes, which obviously allows a very exact estimation of the heat of the furnace, which as we have said is the best guide. Nevertheless the use of smoked glasses may be recommended to any workers specially detailed to attend to the firing or to any one exposed to the heat of large-sized muffles. [Note.—If used solely as a protection to the eyes the translator prefers large goggles of plain glass, to smoked glasses.]

We will now consider the various styles of processes which lay under contribution the decorative resources of enamel, remembering that plane surfaces have served as a type for the description of the time-honoured methods of enamelling.

Champlevé Surfaces.

Their title indicates that these surfaces have been previously hollowed out or sunk with a graving tool very carefully and to an even depth, or that they have been mechanically stamped in a die, in such a way as to form "champs" or cells, which are destined to be filled with enamel to the level of the upper surface of the metal.

The depth of these cells or sunken spaces is a matter of importance, and must receive due consideration, bearing in mind the nature and density of the enamels to be used. Champlevé for opaque enamels always needs a certain depth in order that the enamel should cover (to use the technical term), that is to say, completely hide the metal which forms the bottom of the cells, presenting a dense compact appearance, that, barring a few exceptional cases, being the effect required of opaque enamels. The pickling of a champlevé article requires careful attention, as any trace of oxidation left in the base or on the sharp angled sides of the cells would sully the purity of the enamels, particularly light shades, producing an unpleasant dark line round the edges of all the spaces.

The enamels are applied in the usual way, in two or three coats of moderate thickness, bearing in mind that the last coat should rise slightly above the upper

surface of the metal, otherwise, as the level of the enamel sinks slightly at each firing, the final coat might be slightly concave. In certain somewhat rare cases the final coat is piled up somewhat so that when fired it remains in relief. This is called enamelling “en goutte de suif,” that is tallow drops.

When an article is enamelled with one colour only the enamel may safely be allowed to run over the upper surface of the metal and even cover the lines dividing the cells, in which case, of course, the process of filing will be resorted to in order to remove all the surplus enamel. This operation will take place in the first laboratory at the filing bench, and is as follows : the article being firmly held in one hand is supported on the peg fixed in the front of the bench, and then with the other hand the article is vigorously rubbed over with a stick of emery or other abrasive thoroughly wetted with water ; this is most important, as is also the necessity of holding the emery stick very flat (see Plate III). By this means the surplus enamel is ground away, and the surface levelled, and the dividing lines of metal will be gradually exposed, having under the action of the file a brilliant appearance.

The filing being finished, the article is copiously washed, then well rubbed with a brush of stiff bristles and moistened pumice powder to remove all traces of emery, again washed in running water and dried on a clean linen towel ; the surface of the enamel then has the appearance of ground glass. The article is then placed on one of the planches and introduced into the muffle, but not too hurriedly, for a final firing which will restore its original glaze. Sometimes

the enamel is "crowned" with a coat of enamel applied over its whole surface in order to increase its brilliance. In this case a final filing and firing are necessary as just described.

It may sometimes happen with a transparent enamel that sufficient depth of colour is attained before the cells are filled; in that case the necessary level can be obtained by applying a coat of flux where necessary.

Chased and Stamped Surfaces.

The same principles apply to these surfaces as to the preceding although there is no question, as in champlevé, of attaining a perfectly level surface of enamel. The object in view is to cover with a fairly uniform coating of enamel, a modelled surface having the irregular depths and varying contours of sculpture in bas-relief. This process indicates the practically exclusive employment of transparent and particularly translucent enamels; it is in great favour in these days, and is employed almost exclusively on the noble metals of high standard. If the chasing or carving is not in too high relief, commercial articles can be enamelled in one coat of fair thickness, but more usually two coats are given, the first just covering the highest points of the modelling, the second applied where necessary to make up for the shrinkage of the enamel in firing. In any case too thick a coat of enamel must not be applied, as this would produce a heavy unpleasant effect, smothering the design instead of modelling it agreeably.

Any filing necessary must be done with the greatest care, otherwise there would be the risk of cutting through the enamel into the surface of the metal.

This style of enamel is usually crowned with a thin coating of flux.

Shaped Articles.

Shaped articles are by no means easy of execution, requiring great care and manipulative skill. As far as possible the designs should follow simple lines, which need not exclude graceful curves, and experienced metal-spinners and turners can execute a great variety of forms in all metals. It is not necessary, in fact it is a disadvantage, to have the metal very thick, as thin sheet when spun possesses sufficient rigidity. Further, if it is absolutely necessary that the articles should be of peculiar outline, or that from their size they present serious difficulties in enamelling or firing, these difficulties may be overcome by making the article in sections, providing these sections "register" accurately.

Articles of this nature almost invariably require counter-enamelling and if it is awkward or impossible to execute this with the point, some of the decoction of quince pips or gum dragon may be mixed with the enamel, making a very thin paste, which must be spread over the metal as evenly as possible by means of a fairly stiff painting brush. A similar result can be attained by making a thinner paste, which is poured into the interior of the article, which must then be twisted round fairly rapidly so that the counter-enamel adheres evenly over the whole surface; it must then be dried out quickly to prevent the counter enamel running down into the bottom of the article.

The actual enamelling is effected in the usual way but it is advisable to dry out the enamel fairly

frequently, as an excess of water will cause the enamel to run or drop off, thus spoiling the regularity of the work.

One can also, as already mentioned, paint over the article with a thin layer of either of the gums. This helps to keep the enamel in place. Care should also be taken that the coat of enamel is thicker at the top of the article than at its base, the diminution being as gradual and equal as possible, bearing in mind that during the firing the enamel of its own weight will tend to sink to the base of the article, the more so the closer the sides of the article approach the vertical. It is for this reason that in certain cases special precautions must be taken to counteract this tendency. For the same reason it is advisable to reverse the position of the article when firing. The drying must take place very gradually, carefully observing all the instructions already given.

Cloisonné.

A type of work of great antiquity and essentially Asiatic. As its name indicates, this process, which requires much manual dexterity and no less patience, consists in decorating any article, of plane or shaped surface, by means of thin flat wires which being bent to the outline of the design form cells called "cloisons," which are filled in with enamel of varying shades. These wires are usually of gold or copper, occasionally of silver, and are called "cloison" wire. They are of an average width of 1 to 2 mm. and can be obtained on reels or in hanks.

The following are the technics of this style of work. When the design has been decided on, a working drawing and the article to be decorated are prepared.

The latter may either be covered with a uniform coat of flux or the design may be executed on the bare metal. The first step is to faithfully reproduce the design in the flat metal wire, and it is evident that simplicity of design will facilitate this work, and also that it is wise to avoid complicated broken lines except in the case of shaped articles of which the contours will necessitate the use of short wires. Long straight lines and disconnected pieces must also be avoided, as these would probably fall over on their sides during the firing, instead of remaining vertical. These are important points which must not be overlooked when the designs are being prepared.

To reproduce correctly the outlines of the design, a few special tools familiar to jewellers will be required, comprising pliers, tweezers, mandrels, both cylindrical and oval, etc., these latter being used to assist in forming the curved lines. It is evident that considerable manipulative skill is required in shaping the wires, and also to avoid their becoming distorted in any way. It is therefore a good plan in difficult cases to call in the aid of the professional jeweller—in fact, in certain establishments the “cloisonné” work is the result of collaboration of two distinct workers, the jeweller and the enameller. We may now proceed to details of manipulation.

For facility of working the wire may be cut into strips 15 to 20 cm. long, this length being amply sufficient for the execution of even a complicated portion of the design. The surplus ends of the wire can be cut off at right angles to the edges with a pair of fine shears. Before considering the wirework completed all the parts must be assembled on the article itself,

so that any errors in the shapes may be corrected, as it is absolutely essential that the wires—rigid and perfectly vertical—should fit exactly to the contours of the article.

In the meantime a tracing of the design should be made and transferred to the article by means of carbon or other transfer paper.

As already mentioned, the cloisons can be applied either directly to the metal, or the article could have a preliminary coating of flux. For various reasons preference may be given to the second method, but a consideration of both may be useful. The first method, usually employed for articles of little value made of copper with wires of the same metal, is as follows : the lower edge of each cloison or part of a cloison is dipped in a solution of gum dragon and is immediately placed in its proper position over the tracing which has been made on the article. This somewhat “niggling” work is done with the aid of a pair of tweezers, and care must be taken that the wires fit the articles closely, which may sometimes necessitate slight corrections ; the gum dries fairly quickly and is just sufficient to hold the wires to their base. When the whole design is completed, the cloisons must be firmly fixed in place by one of the two following methods. First, particles of solder about the size of a pin’s head must be carefully placed—with a little borax—on either side of the wires, at distances apart of about a centimetre or less according to the size of the cloison, and then melted by means of the blowpipe. Silver or other solders may be used, but never any containing tin or lead. An alternative method may be employed, thus : The surface of the article is scraped with the

point of a penknife to brighten it, the cloisons are applied as instructed above, and then with a fine "point" tiny blobs of finely ground flux are applied to the cloisons in the same manner as the solder, and the article is then dried and fired at a moderate heat so as to just fix the wire ; if this should have got displaced or distorted in the firing, it can be corrected by the aid of the tweezers. This system, however, is very inconvenient if it is found necessary to pickle the article, as it is very difficult to follow out the regular rules for this process, and in any case this method is only suitable for common work in opaque or dark-toned enamels

Preference, therefore, should be given to the second method, which consists in covering the whole article or those parts which are to be enamelled with a sound coating of flux which has been fired sufficiently to bring out the "colour" of the metal. That done, the cloisons are applied in exactly the same manner as in the first method but no metallic solder is used, the cloisons being simply kept in place on the fluxed surface by the gum solution. A few little blobs of flux may safely be applied here and there, particularly if the cloisons are of any size, as this will help to prevent slipping or distortion during the firing, this must take place at a moderate heat just sufficient to allow the cloisons to sink *lightly* into the flux and remain fixed there without any distortion.

That done, the *cloisonné* is now ready for filling in the cells according to the design (see Plate III).

Two or three coats of enamel will be applied in the usual manner fairly thickly, as the enamel always sinks appreciably at each firing. As has already

been noted, the last coat must remain slightly in relief, and the last stage is to file over the whole article with an emery stick in the same manner as for the champlevé, so that the upper edges of the cloisons are all exposed and the enamel is on a level with them. The filing must be done very smoothly and without too much pressure in view of the fragility of the wires, which might be crushed if the enamel were left in the hollow. After a vigorous brushing with pumice powder to remove all traces of emery, the article must be well washed and dried. Finally, it is fired once more to glaze the enamel and run it smooth. If desired a "crowning" coat of flux can be applied, but that would alter the character of this work, in which the bare edges of the wire should always be apparent.

Translucid or "Plique à Jour" Enamels.

Another style requiring very delicate manipulation of somewhat limited application: this style may be employed for such articles as cups, lampshades, small goblets, jewellery, etc., these articles showing the real nature of the work when they are in such a position that a bright light can pass through them in the same manner as a stained-glass window. It is hardly necessary to say that only translucent or at any rate very pale transparent colours can be employed. This style has a certain resemblance to cloisonné, though it differs essentially from this latter in that the cells to be filled in have no base, and this is the principal difficulty, seeing that the enamel is to be held solely by the narrow flat sides of the wires which form the ornament, the whole presenting the appearance of a stained-glass window.

Any of the metals already considered can be employed in the manufacture of the article. Gold or copper is mostly used, though sometimes silver is employed, as in filigree spoon handles.

The cells are either stamped out in a press, or saw-pierced work appertaining more particularly to the jeweller, who will deliver the articles ready for enamelling. The preparing is done in the usual way, special attention being given to the sides of the cells, to which the enamel has to adhere.

A study—as a type of the whole—of the relatively simplest form, that is a plane pierced-out surface, will be useful. There is only one process with several variations of which the four principal ones may be considered.

On one of the fireclay planches, suitably covered with ochre, is placed the article to be enamelled, as nearly as possible in the centre of the planche.

As the enamelling, contrary to the usual practice, is to be executed on the planche itself, but not in contact with it, a sheet of one of the four following materials, slightly larger than the article to be enamelled, must be inserted between it and the planche.

1st, A sheet of platinum foil

2nd, , , gold foil

3rd, , , mica—infusible in the enamelling oven,
the most practical and cheapest.

4th, , , copper foil, which has been pickled, and
of which the edges can be turned over
on to the article.

If so desired, and according to the nature of the work, either of these materials can be fixed to the article

by means of thin iron wires forming a grid of wide mesh, supporting the foil and gripping the edges of the article, otherwise it is evident that the article must remain on the planche until the work is finished so as to be in constant contact with the foil (see Plate IV).

Contrary also to the usual practice, the enamels for this style of work must not be finely ground, in fact the grain must be very coarse though regular and thoroughly washed as usual. Before enamelling the sides of the cells must be given a slight coating of the gum dragon solution (gum arabic can also be used); this helps the enamel to adhere to the cells.

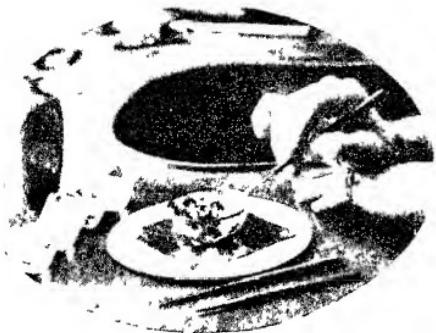
The enamel must be placed in the cells very regularly, and fairly thickly, being particular to make it adhere to the gummed sides of the cells. The skill of the craftsman will enable him to form as dense a mass as possible, so that when fired the enamel forms a block within the cells; the water must be dried out with the towel, the article dried in front of the furnace, using every precaution, then fired moderately, keeping, of course, the sheet of foil between the article and the planche.

The enamel will, of course, adhere firmly to the gold and copper foil, partially to the mica, and probably not at all to the platinum.

The second coat must also be applied fairly thickly so as to finish the enamelling in two coats if possible, the second firing being rather heavier than the first. If the work has been carried out according to the rules, the enamel will adhere firmly to the side of the cells forming in each a clear sound mass.

As already mentioned, the gold foil will adhere to

PLATE IV.



Executing a "plique à jour" or
"translucid" enamel



"Decapage" Preparing an
article for enamelling



Doming-up a "plaque"



Smoothing an enamelled surface with a
spatula

the enamel, and this can be removed either by filing with a wet emery stick, or by dabbing it with or soaking it for a few minutes in a tepid solution of aqua-regia (see p 24), avoiding as far as possible any contact between the acid and other parts of the metal, particularly if these are of gold.

Mica adheres very feebly, and will usually disappear if well brushed with water.

Copper adheres firmly and can be removed by being dipped for some time in a bath of pure nitric acid, again avoiding contact with the other parts of the article. Care must be taken not to inhale the noxious fumes which are given off in this process.

Usually in this style of work the enamel on both its faces is purposely left slightly rough and uneven, but if it is desired to make it brilliant and even, it is fairly easy to do so by filing with the emery stick and brushing out in the usual manner.

As this necessitates a further firing, a sheet of mica can be successfully used or the article can be supported on a stand of broken pieces of planche, or by other similar methods. Enamels, in *plique à jour*, permit light to pass right through them, particularly if held vertically, a position which imparts great brilliance, but they can also be deadened or toned down by the process of matting which will be described later.

The enamelling “*à jour*” of shaped articles is carried out in exactly the same manner as just described but requires even greater manipulative skill, being complicated by the necessity for further special material. For in this case each article must be enamelled and fired with the protection of a “former” or mould, that is to say, a faithful reproduction of the

article which will fit into the interior of the latter faithfully following every contour.

This "former" should be made, by preference, of fairly stout sheet iron (15 to 20 mm.) on which gold or platinum foil will be fixed, or better still thin sheets of mica.

In conclusion, a few other methods, based on the foregoing principles, may be briefly touched upon. A copper article is coated on both sides with flux, and gold cloisonné ornaments applied. This side is then covered with wax or varnish, and the flux on the other side eaten away in hydrofluoric acid, the copper thus left bare is in turn dissolved in pure nitric acid, thus leaving only the gold cloisons, bedded in a thin film of flux on which enamels of any colour can be applied.

Very small spaces can be enamelled "à jour" by simply applying by means of a stout "point," enamel mixed with the decoction of quince pips, a sufficient quantity of enamel on the end of the point being deftly introduced first into one cell and then another. Finally, spaces of varying dimensions can be filled with splinters of enamel held together and to the sides of the cells with gum arabic : if the spaces are not quite filled at the first firing it is easy to repeat the process. By this method the surface of the enamel will be undulating, this effect being sometimes sought for, as it imparts a robust characteristic appearance to the enamel. If, however, a smooth surface is required it is easily attained by filing, as already described.

Plaques.

Under this title are included plates of all shapes and dimensions, and of all metals, sometimes flat,

but more usually domed, forming the base on which any subject can be executed, either purely in enamels, or paintings on enamel, or a combination of the two.

The careful preparation of such plaques, according to certain strict rules, is of prime importance ; seeing that they will have to undergo many firings (probably ten or more), it is essential that they should withstand this severe trial without failure. A badly made plaque will alter its shape, getting worse with each succeeding fire, notably, it will warp, split, or buckle, or even break, marring if not destroying the valuable work of many hours.

Plaques can be made in any kind of enamels, transparent or opaque ; in the latter case, white or slightly tinted enamels are used, especially if they are intended for painting upon.

In describing the process, a copper plaque will be considered, that being the type most generally used. For this purpose the purest copper obtainable must be used (inferior qualities must be rigidly excluded). The thickness of the copper must be proportionate to the dimension of the plaque, but it must be especially noted that it would be a grave error to conclude that the thicker the copper the better would be the resistance of the plaque to the firing ; on the contrary, owing to the phenomena of expansion and contraction in the firing already referred to, the risks would be greater. Therefore it is sufficient that the copper should be just thick enough to give the necessary rigidity to the plaque. Having procured suitable copper, the procedure is as follows :—

First of all, the exact shape of the plaque must be drawn on a thin sheet of cardboard, remembering that

there will be a slight shrinkage in the firing ; this templet must then be cut out and placed on the sheet of copper and the outline traced on ; the copper is then cut as near as possible to the exact shape with a pair of strong scissors. If the outline is not quite neat enough it can be touched up with a fine *rat-tail* file. It is then advisable to planish the copper so as to close up all its molecules, particularly if the plaque will have to pass through a number of firings ; this useful precaution giving it great resistance. For this process, the copper is laid on a stout plate or anvil of polished steel, and with a flat-headed hammer, also of polished steel, is hammered all over its surface very evenly and for a certain time, always with little sharpish blows (see Plate III). This renders the copper perfectly homogeneous. After that the plaque is to be domed up as much as may be necessary, and the corners turned up, in the case of squares or rectangles ; oval and round plaques being somewhat easier to dome up. It may be said here that unless the craftsman possesses a certain skill in metal working it is advisable to entrust the planishing and doming of plaques, especially if of any size, to a professional planisher, or even to a brazier—craftsmen experienced in this class of work.

For commercial work in quantities, the trade will supply to order small plaques, cut out, domed in the press, and provided if required with a narrow edge to retain the enamel.

For any one who cannot, or does not care to, call in the assistance of one of the craftsmen we have mentioned, the following brief description of the method of "doming" will be useful (see Plate IV).

After the plate has been planished it is placed on

a pad of thick paper (an old book or pamphlet 10 to 15 mm. thick will serve), and with a half-round burnisher of polished steel, held in both hands, rubbed firmly from the centre to the edges. By a rapid movement in all directions it will soon be incurved or domed up to the necessary height. Another method is to make a mandrel or former of wood to the exact shape required, then placing the plate over this it is tapped with a wooden mallet, with sharp short blows, until it takes the exact shape of the mandrel. This is the method usually employed by professional planishers.

When the plaque is domed sufficiently, its shape equal and its edges flat, it will be found to have acquired remarkable rigidity ; during the following operations it must be handled carefully to avoid distortion.

It is then "prepared," and a variation of the final part of this process is recommended. When the plaque is perfectly clean, instead of drying it in front of the furnace, it should be placed, immediately before the first coat of enamel is applied, into a metal box containing fine warmed sand, previously well washed. This is gently shaken horizontally so that the plaque is covered and rubbed by the sand, which has the effect of thoroughly scouring it : the plaque is withdrawn with a pair of tweezers and, holding it carefully in one hand by the edge, the sand is cleared away with a brush of very soft bristles. It must be repeated that on no account should the plaque be "blued" before being coated with flux or any other enamel.

The following is another, slightly different, method : the plaque, having been domed up, is plunged for a few seconds only, in an earthenware or china bath containing pure nitric acid ; the plaque must be removed

quickly by means of an old pair of tweezers, as the action of the acid is very rapid. This treatment imparts a great brilliance to the copper ; a copious washing must follow immediately, then the drying on a clean linen towel, and a final slight warming in front of the muffle. The pickling and drying being completed, the enamelling must be proceeded with at once, following the general instructions in Chapter VII, but in this particular case, before applying any colour either transparent or opaque, the plaque must have, both front and back, a coating of flux of moderate thickness carefully smoothed with a spatula. If the plaque exceeds 12 or 15 cm. in diameter it is advisable not to fire it directly on ochre-covered planche, as would be done with a stouter article, but to support it on a template of sheet iron 1 to 3 mm. thick, shaped to fit the underside of the plaque, and thickly coated on its upper side with ochre. This support must be used at each firing, to preserve the plaque from any distortion or sinking. It is also necessary that the diameter of the template should slightly exceed that of the plaque to prevent the edges of the latter from burning—which may also occur if they come too close to the sides of the muffle.

It is very important that the first firing should be very moderate, just enough to vitrify the enamel, so that on cooling it has the colour of a garnet or bigaroon cherry.

The second coat of flux, which is also applied to both sides of the plaque and smoothed with the spatula, must be much thicker than the first one ; the furnace must be at its maximum heat and the plaque should have a sharp strong firing, so that the enamel

is perfectly glazed, and that when cool the copper appears its natural salmon-pink colour, and free from spots or stains. Unless these instructions are carried out to the letter the flux might draw back in places, leaving bare spaces on the copper which would oxidise, this would necessitate a further pickling, in spite of which the plaque would run the risk of being more or less stained. The fluxing being successfully completed, the plaque is now ready to receive one or more coats of colour, either transparent or opaque, for these latter two coats at least will be required, especially for white enamel, and when it is necessary to completely disguise the colour of the copper.

With plaques, more than for any other articles, it is advisable to give an equal number of coats both back and front, of equal thickness, and of the same enamel ; all the same, too heavy a coating of enamel would give the plaque a clumsy appearance, without in any way increasing its strength ; on the contrary. After firing the last coat, and particularly if the plaques are of white enamel destined to be painted on, they must be carefully filed with an emery stick and water. Then having been well brushed and washed and wiped, a final fire is given as previously described. One important point is to be noted here : at the first and each succeeding firing a thick coat of oxide is formed on the edges of the plaque where the copper is left bare, and if this is not removed at each succeeding firing the result would be that immediately cooling commenced, this oxide of copper would scale off in tiny flakes sticking to the enamel while still soft, and also at the beginning of the firing ; these flakes split up into innumerable black spots, of a most

disagreeable appearance, especially on white or pale colours.

To avoid this trouble, after the first and succeeding firings the edges of the plaque must be filed with a rat-tail file, to make them perfectly clean ; this must be very carefully done, filing always in one direction only—as a to-and-fro movement would crack the edges of the enamel. Any odd black specks which may nevertheless appear can be removed with a sharpened steel point, or graving tool, the little resulting hollows being deftly “remised” with a speck of enamel, and the plaque finally fired at a moderate heat to smooth the surface.

Standard Samples and Range of Colours—Types of Enamel Fired on Metal.

For the satisfactory execution of works of art as well as for the production of more commercial articles, it is necessary to test the enamels thoroughly so as to become well acquainted with all its properties : colour, density, fusibility, resistance, etc., so as to be assured of its working qualities. Therefore to obtain satisfactory results it is necessary to prepare in the first place, fired samples, of which the nature and structure will resemble as closely as possible the article which is to be enamelled.

Thus, the metal, its thickness, decoration, etc., in one word the general design of the sample, must in every way correspond to the article in view to ensure the exactitude of the test.

The artist who makes free use of enamel in many tints in the interpretation of his work, especially if

on copper or other virgin metals, will find it an advantage to group his standard in one or more series of colours in the following manner :—

1st. For Transparent Enamels.

On a square or rectangular plaque, previously fluxed on both sides, lines about 1 mm. wide should be painted with black vitrifiable colour; these lines should run both vertically and horizontally, thus forming a chequer of which each space should be about 1 cm. square. In the upper part of each space should be painted, also in black, numbers previously decided on, to correspond with the enamels to be tried; the plate must then be fired to vitrify both the lines and numbers.

That done, the second row of squares from the top is covered with a thick but very even coat of white enamel fairly hard, which must at once be fired sufficiently to run the white smooth. (The top row of squares is left bare, that is to say, with only its original coating of flux.)

The squares in the third row will each be covered with a square of platinum foil, and the following rows respectively with yellow gold, green gold, and silver foil—which are then “fixed” by giving the plaque a moderate fire.

It will then be seen that if any transparent enamel which it is desired to test, is laid in an even coat over one series of squares, from top to bottom, it will be subject to the influence of the different substances forming its substratum, thus giving a range of effects to which the artist may make profitable reference.

One can also, if desired, see the effect of a double coat of enamel, by laying this second coat over half only of the squares, either transversely or diagonally.

As already mentioned with regard to platinum, a certain number of enamels will not adhere to this metal : this method will give excellent proof of those which offer the best chances of success.

2nd. For Opaque Enamel.

Proceed in the same manner as the foregoing except that each enamel will be applied in two coats on one square only, the plate having been previously fluxed as usual.

Opaque enamels being practically unaffected by the base to which they are applied, the samples produced by this method will be sufficiently accurate, though possibly the worker who has to consider requirements of a practical nature will prefer separate samples. To this end a sufficient number of small plaques, round, oval, or rectangular, can be employed for testing the colours. These will be counter-enamelled or not according to the thickness of the metal and will bear a prearranged number, either painted on or engraved in, on either the front or back. These plates will be in one colour only, either transparent or opaque, the first named having only one coat, or if desired two coats over one half, the latter having not less than two coats. It is more necessary, in this case, that each plate should be made of the metal, either pure or alloyed, which is in most constant use for actual work. Otherwise the results of these trials would not agree with those obtained in actual working, rendering them thus of very little practical use.

CHAPTER VIII

ENGINE TURNING

UNDER the title of "engine turning," and especially in Geneva under that of "flinking," are classed two types of engraving, the first mechanical, the second hand work ; in the latter the graving tool, influenced by the mind and temperament of the engraver, will produce many varied effects. Either of these methods will therefore permit of the surface of any article, in any metal, being adorned, bearing principally in mind its decoration, with transparent enamels. An infinite variety of designs can be produced which materially assist in giving "sparkle" to the enamel and also assist its adhesion to the metal. Generally speaking, the greater the value of the metal the greater the care which will be taken with the flinking or engine turning, and usually less care will be taken with fancy articles of a more or less commercial type than on articles "de luxe." The most classical designs in this style are the "flames," "rays" "concentric waves" and a number of other designs bordering on the "ultra-decadent." The arrangement as well as the depth of the cutting will have a considerable influence on the appearance of the enamel. Therefore for deep colours such as reds, dark blues, dark greens, certain opals, etc., a deeply cut and angular pattern should be chosen,

as this will produce a marked effect of light and shade, showing up the beauty of the colours. On the other hand, a restrained, lightly cut pattern with gentle curves, overlaid perhaps with some light design, will give a sparkle to delicate shades, such as light blue and green, lilac, rose, light greys, faintly tinted opals, etc.

It must also be pointed out that designs must be chosen in relation to the shapes of the articles themselves, in agreement with the laws of decoration. Finally, great care must be taken when "pickling" an engine-turned surface, that neither by contact with the acid bath nor in the subsequent brushing, etc., is the vivid brightness of the "cut" sullied in any way, as this deadens the brightness and detracts from the beauty of the enamel.

CHAPTER IX

PAILLONS AND THEIR APPLICATION

PAILLONS is the name usually applied to tiny ornaments or "motifs" of infinite variety stamped out in relief, such as dots, stars, crowns, flowers, fruits, birds, insects, etc. These are cut out of thin burnished sheets of virgin metal, either gold, silver, or platinum, and are applied to the enamel with which they become incorporated, forming charming and often ingenious decorations, it being usually fancy articles to which this brilliant ornamentation is applied.

Of late years certain bold manufacturers have not hesitated to extend this process and overpass the old narrow limits, by producing paillons of considerable dimensions, suitable for decorating enamelled articles of large size. The application of the paillons is quite simple: thus, when the enamelling is finished, the surface being smooth and bright, a plan of the ornamentation is traced thereon, the design having been previously arranged by the aid of the paillons themselves, and with a small brush a little gum tragacanth * solution is applied to those parts; then, still with the aid of the brush, slightly moistened with the gum, one of the paillons is picked up and placed in its exact position on the enamel the relief side upwards, and this

* Or gum dragon as it is frequently called.

is repeated until the design is completed. The gum dries quickly, attaching the paillons temporarily to the enamel. They must then be fixed finally by giving the article a moderate firing, just enough to make them hold to the enamel; too heavy a firing would cause them to sink in and also lose their relief.

Paillons are always protected by two coats of flux, of the appropriate type for the purpose, prepared with particular care, and applied in the manner employed for covering enamel painting, of which a full description will be given in the second part of this manual.

Being very fragile, precautions must be taken not to distort the paillons or tear them away from the enamel, and the flux must be applied with great care, using a small spatula with a rounded point, or better still a brush.

After firing, the second coat must just cover the highest parts of the paillons, thus making them sparkle and appear as though under a glass. The flux is then usually polished.

Further, it is evident that any pale-coloured enamels can be used as the flux, imparting a slight tint to the paillons and producing very agreeable effects.

Under this same heading must be mentioned that for several years past a type of paillon called "piergeries" have been in use for decorating articles of a commercial class. These are practically the paillons already described but generally limited to dots or other simple forms of which the hollows are filled with enamel, green, blue, or red, in imitation of precious stones—emeralds, sapphires, rubies. Finally, it must be noted that this same term, paillon, is applied to exceedingly thin sheets of pure metal, yellow or

green gold, silver, or platinum, sometimes burnished but more usually matt : these sheets are seldom larger than 10 cm. square and are used for cutting out such motifs as vestments, head bands, or such-like ornaments : these being eventually covered with transparent enamels to which the virgin metal imparts an incomparable brilliance. The larger the motif the more difficult is it to cut out and apply : it is advisable, therefore, to divide into sections any work of large size (these paillons are the same as those which serve as temporary base for enamelling "*plique à jour*" as described in Chapter VII). The motif to be cut out of the paillon is first drawn on a sheet of tracing paper. The paillon is laid on a piece of stout smooth Bristol board, or on a board of very smooth pear-wood ; the tracing paper is placed over this and held firmly and perfectly flat with the left hand : then with a highly sharpened penknife or a lancet, the outline of the motif is cut out with a firm neat stroke (for cutting straight lines a metal rule can be used as a guide). It must be remembered that to cut on the bare metal would mean tearing the paillon ; it is therefore essential that it should be cut under the protection of the tracing paper. Fixing the motif by firing requires considerable dexterity to avoid crinkling or blisters, as it must first be fixed temporarily to the enamel with a little gum water ; this naturally on heating will form a certain quantity of vapour, which would cause the disastrous defects just mentioned if innumerable but minute holes were not previously pierced in the paillon to allow free passage to this vapour.

There are several ways of attaining this result.

Here are two : the heads of about a dozen fine needles are pushed well down into a piece of cork about 2 or 3 cm. diameter, thus making a bundle of fine points. The paillon which is to be perforated is placed on the Bristol board, covered with tracing paper, and then tapped lightly with the needles, holding these vertically, going carefully over the paillon so that every part is well perforated. A similar result can be obtained by passing over and over the paillon—always protected by the tracing paper—a small wooden roller, the edge of which has been covered with glue on to which has been dusted coarse emery powder, or a strip of coarse emery cloth glued on to the roller will serve equally well.

Paillons can, if desired, be decorated with a quasi-engine-turning by using a plate of copper or brass on which various designs have been engine turned in the usual manner ; the paillon is laid on this plate, covered with tracing paper, which is held steadily in place with the left hand while the surface is firmly rubbed over with a piece of polished wood, such as the end of a penholder—care being taken not to tear the paper. Engine turned or not, the paillon motif being perforated it now remains to apply it skilfully to its proper place on the enamel. This must not simply be dabbed with the gum tragacanth solution, but a very thin and even coating must be applied, so that there is the least possible amount of water, to obviate the difficulty already mentioned. (It may be mentioned here that as the gum solution deteriorates after a certain time, it is advisable to use it as fresh as possible.) The paillon—free from the tracing paper—is then carefully lifted by means of a pair of corntongs, but it

is useless to attempt to apply it in one stroke to the enamel ; on the contrary, this must be done in stages starting with one end of the paillon and working up by degrees, pressing gently on the paillon with a wad of cottonwool so as to drive out any air which might otherwise be imprisoned under the metal. A piece of tracing paper is then placed over the paillon, and the pressure of the pad of wool increased to ensure the perfect adherence of the paillon to the enamel. The final fixing is done by giving the article a gentle firing, it having been thoroughly dried in front of the furnace to allow the water in the gum to vaporise and so escape. If through any mischance blisters appear in the surface of the paillon, further perforations must be made and the work refired.

After firing, if it is thought desirable, a rough and ready style of enamel painting can be executed on the paillon, or an appearance of modelling can be obtained by shading lines or cross-hatchings, done with a sable brush and a dark vitrifiable paint (usually iridium black). A very light firing is then given, after the usual drying, just sufficient to cause the colour to adhere.

The subsequent enamelling will of course be done according to the ordinary rules.

CHAPTER X

“MATT” ENAMELS

IN order to lessen the brilliancy of the enamels and to impart a subdued tone, not without charm, the process of “matting” has been generally resorted to for a number of years past.

Originally this result was obtained in a crude and costly manner by the process of “sand-blasting,” or by the use of the highly dangerous hydrofluoric acid or its fumes; but now, thanks to the introduction of a liquid called “mate-email,” this operation is rapid, economic, free from danger, and gives results never before surpassed, with very little apparatus, and if the instructions given with the solution are carefully followed, a few minutes will suffice to produce a matt surface of great regularity and incomparable texture.

In closing this chapter, however, it must be noted that enamel surfaces which have been matted, being much more readily soiled than those which remain glossy, must be treated with care, and the process is therefore hardly suitable for articles likely to be rubbed, or subjected to much handling.

CHAPTER XI

FILING AND POLISHING ENAMELS

It has been mentioned in various parts of this work that under certain circumstances enamels require filing. In executing certain styles of enamelling, particularly the champlevé and cloisonné, filing is absolutely necessary, as there is invariably an excess of enamel which spreads over the edges of the cloisons, and, hardening as it cools, hides the outlines of the designs, and must be removed.

Filing is usually done by hand, square sticks of emery being employed ranging from coarse grit used for the first roughing over to the finest grain for the finishing filing. Filing is always done wet, the article being held in the left hand; the file must be passed over the work in all directions but always perfectly horizontally.

During the past few years the trade has supplied files of other materials very suitable for enamellers, these are corundum and carborundum (American stone); from these materials are also made grinding wheels and mandrels of various sizes and shapes for use either by foot or motor power, and these can be very useful for filing large surfaces; nevertheless filing by motor power has its drawbacks if the speed is too high, and

in any case the grinding wheel must be provided with a constant trickle of water.

Filing must always be followed by a vigorous brushing (by hand or mechanically) to remove all traces of the abrasive, then thoroughly well washed and wiped, then finally fired to restore the glaze.

In certain cases the final finish is put to an enamel by polishing, which gives to the surface of the flux covering the work (especially in the case of delicate enamelled jewellery or paintings on enamel) the brilliancy of glass. To this end the article is firmly fixed in a hand vice, using all precautions due to its fragile nature, the surface to be polished being placed horizontally. If the article is flat it can be fixed on a peg with a cupshaped end, the handle only being fixed in the vice. The cup of the peg is filled with brown wax, which is supplied by trade chemists for that purpose, and the article is stuck on to the wax : this wax can afterwards be soaked off with rectified benzine. The enamel, or more generally the flux with which it is covered, is polished by means of a lathe provided with one or more wooden chucks of hard wood, pear or apple wood for preference. During the operation the chuck must be kept well covered with tripoli powder and water, this can be done by means of a piece of cloth soaked therein and the chuck must be kept constantly wet ; the article on its peg is pressed lightly against the revolving chuck, and five to fifteen minutes should suffice to impart a high polish to the enamel. If an extra finish is required, as for a specially choice piece of jewellery, watch cases, etc., a final polish is obtained by means of a tool called a cabron ; this consists of a long flexible strip of wood covered with

felt and provided with a handle. The felt must be well smeared with very wet tripoli ; then, holding the cabron in both hands, it is lightly passed over the work, which is fixed on a mandrel firmly held in a vice (see Plate III). This operation will take from five to ten minutes ; the article must then be washed out and dried with a flannel or piece of silk. In view of the very important part played by the tripoli in this process it is most essential that this material should be of the very finest quality, which may usually be obtained from trade chemists. All the same, the trade never supplies it in a fit condition for use, so it is necessary to wash it in order to free it from any coarse grain which might scratch the enamel.

To wash tripoli, a suitable quantity is placed in a deep bowl, which is then partially filled with cold water ; the whole is then well stirred with a piece of stick or glass rod. Before the mass has time to settle the upper portion is removed by means of a small tumbler or dipper and placed in another bowl or jar ; it is this portion only, freed from any coarse grains, which will ensure a perfectly polished surface.

Needless to say it must be carefully protected from dust.

CHAPTER XII

ON THE HARDENING AND SOFTENING OF ENAMELS

IT will sometimes happen that a certain amount of trouble may arise from an enamel, of suitable tint, being too fusible to be fired in company with other enamels of normal fusibility. The trouble might, of course, be obviated by applying this extra fusible enamel at the last firing only, if the nature of the work permits; but this is not always the case, and more often than not, all the tints must be fired together coat by coat, from the first. To raise the melting point of any extra fusible enamels so that it corresponds approximately to the normal, it is necessary to harden it in the following manner. After the enamel has been ground as usual, it must be placed in a glass or porcelain beaker and covered with pure nitric acid, then stirred with a glass rod for five or ten minutes. The more fusible the enamel, the more rapidly it will harden, that is why the time required for the operation will vary considerably, the effect of the acid being to dissolve a portion of the basic fluxes of the enamel. The acid must then be thrown away, the enamel replaced in the mortar in which it was ground, and thoroughly washed in many changes of water, gently stirring it with the pestle, but carefully avoiding any further grinding, the object being simply to eliminate

every trace of acid. If, on the other hand, the enamel is much harder than the others with which it is to be employed, it must be applied alone from the first firing as the nature of the work and the quality of the metal permit.

If this is not possible, the trouble can be obviated by adding a certain amount of extra soft flux to the hard enamel, the amount of flux must be determined by circumstances. The two enamels must be ground together from the first so as to form an intimate mixture, thus raising the fusibility to the normal point. This plan is best adapted to transparent enamels, as these are rarely very hard, and are easily incorporated with the flux, of which a small quantity will cause a marked difference in the fusibility.

On the other hand, the use of flux in conjunction with opaque enamels is not so satisfactory, seeing the difference in their composition.

Satisfactory results can, however, be obtained if the enamels are ground together to an extreme degree of fineness, the excess of bases in the flux compensating for their insufficiency in the enamel.

CHAPTER XIII

REPAIRS

It will often happen that an enamelled article gets damaged more or less either by a blow or undue pressure; the enamel may even break away, leaving parts of the metal bare.

Repairing, it must be said at the outset, requires great manipulative skill, patience, and above all experience of the craft, to determine how best the reparation can be successfully effected with the least handling, and in particular the minimum number of firings, in order that the enamel may not suffer further with the possibility of being irretrievably spoilt.

Often, on a weak portion of an article, it is necessary to repeat the whole process employed in its original creation, with the added complication and risks inherent to refiring an article already enamelled. Only a practised eye can determine with relative accuracy the shade or shades necessary to effect an invisible repair. It is also evident that when an "enamel" is mounted in an article of jewellery or goldsmithing it will be necessary first to remove it, so that that part to be repaired, and that only, can be easily handled whether it is to be in enamel or painted, as when originally made.

As far as possible, only readily fusible enamels

must be employed (or enamels softened by the process described in the previous chapter), so that the repair can be effected with a minimum firing.

If an enamelled article is cracked to a greater or less extent, it is sometimes possible to mask the defect entirely with a coating of soft flux having special flowing properties : if the cracks are of slight extent only a thin coat of the appropriate flux applied over them will serve, soldering the edges of the cracks together, so to speak, under the action of the firing.

If, however, the cracks are of great extent or pieces of enamel have actually broken away, it will be necessary to start the work from its commencement, including possibly burnishing out bruises from the metal, retouching the engraving or engine-turning, preparing, enamelling, filing and polishing—all of which processes have been fully described in their respective chapters.

To conclude this chapter, there are a few further points of importance to be considered.

If there are a few particles of enamel adhering which might affect the work of repairing, or if for some reason or another it is advisable to remove all the enamel, this must be *dissolved*, to use the technical term.

There are three methods of doing this :

1st. The enamel can be dissolved by contact, for from twenty-four to forty-eight hours, with the liquid called "matte-email," already mentioned in Chapter X on "matting the enamels."

2nd. The same result may be attained, but much more quickly, by heating the article in the furnace and, while it is still at a dull red heat, dabbing the enamel with caustic potash : this attacks the enamel with violent effervescence, and to complete its dissolution

the article must then be plunged into a bath of cold water. If all the enamel has not disappeared, the operation must be repeated. Great care must be taken in handling the caustic potash, which is in the form of round sticks : old gloves should be worn or an old rag used.

3rd. At the present time, pure hydrofluoric acid is employed very considerably for dissolving enamel, but great stress must be laid on the fact that this is a very dangerous acid to use, and must never be allowed to get on to the fingers, as it will cause very severe burns : even the fumes which arise from it are extremely noxious.

This warning given, a suitable quantity of the acid is poured into a jar or basin of lead, or preferably gutta-percha (a capsule formed from an indiarubber ball cut in halves will serve), into which the article is placed ; the pan must be kept in some airy spot where the fumes cannot affect the eyes or respiratory organs of the workers. The article will remain in the acid until all the enamel is dissolved ; this will be in an hour or so, or perhaps longer, according to the nature of the enamel. The article must be removed by means of an old pair of tongs, well washed and brushed.

This last process has the great advantage of not affecting the brightness of the enamel.

In many cases, in order to restore an article to its primitive appearance, it is simpler to remove the whole of the enamel rather than to attempt a repair which might only accentuate the damage ; but frequently it may only be necessary to repair one particular portion, a single cell or cloison, for instance, while desiring to preserve the remainder. To this end, a

process of blocking-out is resorted to, that is to say, protecting certain parts from the action of the acid, by covering them with a thick coat of resinous matter such as bitumen, pitch, gutta-percha, or even suitable varnishes or wax, which are spread over the parts to be preserved after the article has been slightly warmed.

The enamel being dissolved, the protective coating is removed with methylated spirits or benzine.

This process of blocking out is only suitable to methods 1 and 3, and can obviously be conveniently employed when it is desired to partially "matt" an enamel surface. Finally, as in certain delicate cases it is absolutely impossible to repair an article with fired enamels in the manner just described, either because the article itself could not stand the effects of further firing, or that the question of expense or other reasons intervene, the repairs may be effected with cold enamels. These are transparent spirit-varnishes, fairly fluid, and which are applied with a brush directly on the metal. (The shades are generally limited to the primary colours—fairly dark—which naturally entails recourse to blending.) Damage to opaque enamels can be repaired by means of the many enamel paints and lacquers supplied by the trade.

CHAPTER XIV

PICKLING—CLEANING THE METAL AFTER ENAMELLING

For this purpose the same acid bath is used as in preparing the metal for enamelling.

The pickle is brought to boiling-point in a copper pan, and the article placed in this and allowed to remain for two or three minutes, then withdrawn with a pair of tongs, when it will be noted that the metal has resumed its natural colour, but with a matt surface. Wash well in water and wipe (see Plate IV).

CHAPTER XV

GILDING, PLATING, AND COLOURING OF ENAMELLED ARTICLES

To give a description of these accessory operations would seriously extend the limits of this work, but a few essential points will be indicated which may help to minimise the all too frequent accidents which occur to enamelled articles when they have to undergo the processes mentioned at the head of this chapter.

With regard to gilding and plating, the chief cause of breakages of the enamels is to be found in certain alloys of unsuitable composition or unsoundness of the metals.

Experience indicates that silver 0 935 fine is the most suitable for these operations, while fine copper will give better results than its alloys. Engine-turning, fairly deeply cut, will help to bind the enamel to the metal and assure the success both of gilding and plating, but by far the greater number of failures are attributable to the craftsmen entrusted with this work, who, generally speaking, treat enamelled articles in exactly the same manner as non-enamelled, regardless of the fact that owing to their brittle nature, the former demand special care in their treatment.

Here is a summary of the various causes of these accidents :—

1st. Careless handling : enamelled articles piled together pell-mell, knocked about, brushed roughly, etc., causing scratches and fine cracks, confined sometimes to the surface only of the enamel, or extending and penetrating to the metal under the influence of the gilding and plating baths.

2nd. Rapid changes in temperature of the baths employed, particularly a rapid rise in that of the "metallising" bath, hence rapid transitions must be avoided, and to avoid damage to the enamels, the heat of the baths should always be moderate.

3rd. Too strong an electric current in the baths ; it is known that too high an electric tension will cause the disruption of the enamel from the metal.

In conclusion, colouring is a chemical operation, and consists in treating articles of alloyed gold in an acid bath (of variable composition) ; this bath attacks one or another element of the alloy, imparting a colour to the surface of the metal which is pleasing to the eye and enhances the charm of the article.

As this operation presents, on some points, a certain analogy to gilding, so the same precautions must be observed, especially as regards the temperature of the bath, and above all the strength of the acid, which is usually too high, with the result that the surfaces of the enamels—particularly those easily fused—will be tarnished ; or reactions will be set up causing a metallic film or spots, particularly on dark colours such as black, deep blue, etc.

PART II

PAINTING ON ENAMEL

A BRIEF SURVEY OF THE PRINCIPAL PROCESSES

To undertake a full description of this delicate art, so intimately allied to that which has been the object of the preceding lessons, would overpass the limits of this modest manual, and would invite a serious check, for the difficulties facing the study of enamelling on metals without the aid of a master are prodigiously increased when it is a question of inculcating the many and varied technical principles, a complete knowledge of which can alone aid the student, even though provided with considerable artistic knowledge, to attain satisfactory results, capable of gradual and increasing improvement by constant practice.

Consequently this section will be limited to a brief survey of the most time-honoured processes of painting on enamel, both on account of their close connection with enamelling, and as furnishing a fitting conclusion to this work.

It is obvious that considerable artistic knowledge is an essential basis to the successful practice of this art.

This being agreed it may be noted that enamel paintings are suitable for the decoration of all kinds of

articles, and the base on which the painting is executed may consist of any kind of enamel, either transparent or opaque, although usually white or a faintly tinted opaque enamel is used.

It must be remembered that if the ground enamel is very fusible, the painted colour will have a tendency to sink into the body of the enamel, while if the latter is of average fusibility or even slightly on the hard side, the painting will remain on the surface.

The vitrifiable colours suitable for this art are a matter of prime importance, especially those destined to be covered (*sous fondant*) it is therefore necessary to possess a palette which while complete is not too complicated, and consists solely of thoroughly well tested material, particularly, as already mentioned, those which are to be covered, that is, to have a finishing coating of flux, a process of Genevan origin which is certainly the most recherchée, both on account of its high artistic value and its permanence.

In their composition these colours are closely allied to the enamels, many of their constituents are identical, though combined in different proportions and under very different forms. This close affinity explains why these colours adhere to the surface of, and frequently incorporate themselves in, the substance of the enamel under the action of the fire.

The material needed for the exercise of this art is neither complicated nor expensive. Scrupulous cleanliness and a total absence of dust are the essential conditions for success. A well-lighted room (with northern aspect in preference), fulfilling the conditions of cleanliness, will be quite suitable. The work-bench or table, a small rectangular piece of furniture on four

legs, should have a deep beading round the two sides and back, one or more drawers should be provided in which work in progress can be kept in safety, and finally a frame of lattice-work should be fixed at the back of the bench to support the sketches or drawings required, facing the artist. The work-bench should be placed in such a position that the light falls on the work from the left (see Plate V)

According to the shape of the article, a suitable stand must be provided to hold it in position. Articles which are flat or only slightly raised (the most usual forms) are fixed on an implement called a "boulet." This consists of a semi-hemisphere of hard wood, the flat surface of which is covered with modelling wax, which serves to hold the article in position while being painted; a glazed cover to fit over this is required to protect the work during any interruptions. A solid arm rest, also of hard wood, will support the fore-arm and wrist leaving the hand holding the brush perfectly free, while the other hand will direct the inclination and revolution of the boulet on its hollow stand; in this way the work can be inclined at any required angle. It is also advisable to restrict the field of vision and protect the eyes by wearing a shade over the forehead.

The following are briefly the principal and most usual phases of the process:—

Firstly, it is essential that the colours should be extra finely ground ("surbroyées"); they are supplied in the form of a perfectly dry powder and must be carefully protected both from moisture and dust. A sufficient quantity of each colour for daily use should be kept in small glass tubes well corked, or in little

round boxwood boxes, similar to powder boxes ; these should all be carefully labelled to avoid mistakes.

An assortment of " essences " or " oils " will be required, these forming the only vehicles for the colours.

For laying in the design—the broad masses of a subject—the colours must be mixed with a semi-fat essence so that the paste is not too stiff ; it must indeed be fluid enough to be spread easily with the brush. On the other hand, when it comes to modelling up the subject, and finally to giving those last touches which complete and bind together the design, fat oil must be used in just sufficient quantity to make a stiff paste ; this will permit of firm, accentuated touches which will preserve their relief until the work is completed.

It is of course possible to prepare reserves of colour, ground in fat oil only, to be thinned out as and when required with semi-fat oil, this being done with the brush, but for many reasons preference should be given to the former method.

It is much better to prepare the colours necessary for a day's work each morning ; they are naturally fresher and work much more readily than when prepared some time beforehand, even if they are freshly triturated daily.

To prepare a colour a sufficient quantity is placed in the centre of a slab of agate (failing this a small square of glass or porcelain will serve). At the edge of the slab a portion of the essential oil is placed as a reserve, then with a steel palette knife a small quantity is taken up and added to the colour ; then the whole is triturated with a brisk circular motion, a gentle pressure being applied to the end of the knife (see Plate V). From time to time a greater pressure

is applied so as to disengage the colour ; the little heap of colour is then gathered together and the trituration continued until an intimate blending of colour and oil is obtained. This will take from one to two minutes for each colour. Both slab and palette-knife must be cleaned after each colour with a little spirit and a linen rag. It is advisable to use but very little oil at the start, as more can easily be added if necessary during mixing, as the oil usually tends to be in excess of requirements and that in proportion to its fluidity.

Each little heap of colour should be placed in a definite order on a glass plate, lined underneath with white paper, or on a porcelain plate serving the office of palette. This should be kept in a little box or nest of drawers, which will also serve to hold work in hand as well as the brushes, which though very durable are of a fragile nature.

On this palette will also be placed fat and semi-fat oils ready for use. If the work in hand is to be finished quickly, preference should be given to the essential oils, which evaporate quickly ; on the other hand, slowly evaporating oils should be reserved for work likely to take a considerable time.

Most artists usually prepare beforehand a range of standard mixtures of several colours ; these serve for blocking-in the subjects and should be arranged on the palette in similar order to the original colours. An assortment of brushes of various sizes is required, these should be exclusively of the very finest quality sable.

The heart of the subject may now be considered.

It has already been mentioned that enamel painting can be executed on any shade of enamel either

transparent or opaque, but it must be added here that the ground enamel must be absolutely sound, that is, that it should be prepared and applied strictly according to the rules already laid down.

It would be a grave mistake—a very grave mistake—to imagine that because part or the whole of the ground is to be covered with a fairly thick coat of paint the condition of the ground enamel is of no importance. On the contrary, an enamel of inferior quality or badly prepared—still containing free alkali, carbon, or other impurities which at every firing strive to escape from the body of the enamel and rise to its surface—will have a pernicious effect on the painting, causing blisters, stains, etc.

One method of enamel painting closely resembles water-colour painting, being executed on a ground-work of white enamel, which furnishes the high lights, the modelling being worked up in various colours without the addition of any white. This is the most expeditious method, especially suited to commercial work, and is rarely covered with flux.

On the other hand, the characteristic technique of that class of enamel painting designated “sous fondant,” that is to say, fluxed, presents a marked analogy to gouache or body-colour painting or still more to oil painting. As in this latter, a certain number of transparent colours are employed, others are more or less opaque, and lastly white is freely used, being mixed with the prime colours in varying proportions. This produces a fatty and compact paste, a solid painting can thus be produced possessing a certain relief. This type of painting can be executed equally well on a light as on a dark background, but in the latter case more

white must be used in the mixture, particularly when blocking in the design, when, generally speaking, certain parts of the ground are to be completely covered, and the same holds good when transparent enamels are used for the background.

It has just been stated that this process entails the use of a number of mixtures, and it follows naturally that chemical reactions may occur under the influence of the firing, these reactions possessing both advantage and disadvantages. Therefore, to this delicate and meticulous art must be added the science of "mixing," which can be learnt only by long practice, and a thorough and up-to-date knowledge of the materials employed. This in its turn proves the absolute necessity of using only material which has been thoroughly tested, and is of the utmost possible uniformity.

A thorough knowledge of the results of the combination of various colours and of the effects produced by firing is necessary, as there is a great difference in the appearance of many colours before and after being fired.

The actual execution of a subject may now be considered. Whatever style is adopted a tracing must first be made of the outline of the subject; to transfer this to the enamel a piece of tracing paper of suitable size is rubbed with a mixture of cinnabar or red lead mixed with oil (these are metallic oxides which disappear in the firing). This paper—with the oxide downward—is placed over the enamel, the tracing is placed over this in its proper position, and then, with a pencil or ivory point, the outline is carefully gone over and thus reproduced on the enamel. In these days, the outlines are frequently produced from

engraved steel plates, vitrifiable colours being used. Photography is also called into service; a photographic transfer in vitrifiable colour is fused into the enamel ground, giving all the details of the subject to be painted.

It is after this that the real work of painting commences. There is very little essential difference between the principles of enamel painting and the styles of painting which do not require firing; successive coats are applied, not too thinly, each coat being followed by carefully drying and firing. Thus of an ordinary piece of work it will be said that it is executed in two fires, while a more particular work will take four, six, or even more fires. As it has already been explained that each fire may jeopardise the success of the work, it will be understood that each successive stage of the painting must be carefully thought out beforehand with a view to reducing the number of fires to the absolute minimum.

The first coat will aim to sketch in the subject in masses; thus, for a portrait, the flesh tints will be broadly indicated by a uniform coat of flesh colour sufficiently neutral in tint to serve as a base for the modelling of the features and eventually other parts of the body, always in successive masses each alternating with a firing; clothing, accessories and the background are treated in the same manner, and the same principles apply to landscapes and other subjects. Finally, before the last fire, the final touches must be applied, so that the work is finished in its minutest details. If the painting is to be covered these details can be put in somewhat harshly, as the flux always has a softening effect.

It must be remembered that the quality of the colours plays an important part, and that only those guaranteed *sound under flux* can give successful results. The quality of the flux used for the protective covering is not less important, but it must be remembered that technical skill in the preparation and use of the materials, be it paint or flux, plays an equally important rôle. Referring to the actual process of painting, it must be mentioned that each coat must be of a certain thickness : not exaggerated, but none the less sound, and above all well worked together and homogeneous.

It is important that the colours should not be daubed on with a full brush : the colours, as already mentioned, should have sufficient consistency to enable them to be applied in small touches placed very closely together, which can afterwards be smoothed by light cross strokes of the brush. If too thin, the colour would not be under control ; it would spread and be liable to blister in drying. The high lights are obtained by vigorous and fairly thick touches, the colours being of considerable consistency.

Brushes should be cleaned firstly in methylated spirit, then dipped into a little thin oil to preserve their shape and suppleness. To clean them with thin oil only is undoubtedly the best way, but is more troublesome. A few important points may be noted here : as already mentioned most colours are modified by the firings ; their tones alter, more or less, with each firing, and these reactions are the more marked when colours are mixed together, thus they are sometimes mutually destructive or give rise to very unexpected results.

It is, therefore, only by constant practice, that a

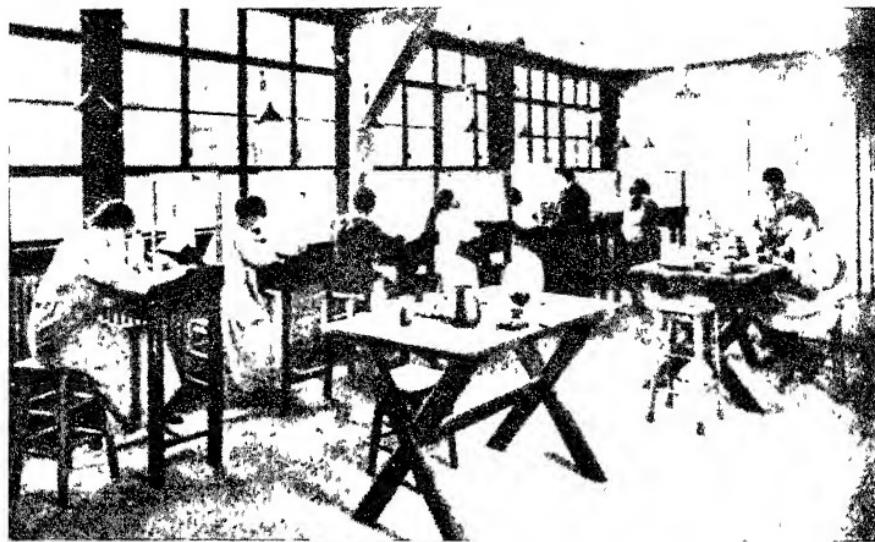
sufficiently intimate knowledge can be obtained, to enable one to judge fairly well how they will appear after firing. It is well also to remember that many colours, even when mixed with oils, have but a very dull appearance and that their brightness and intensity are only manifest after firing. This peculiarity therefore necessitates a constant transposition of tone and value during the progress of the work. Further, for reasons of a technical nature, certain colours are never used for shading as washes or glazes, but only for *fields*. This applies to most of the reds and blacks ; neither should these be mixed with other colours.

Drying.

This operation, delicate but not in itself difficult, requires vigilant attention, and as in the case of enamelling should be done immediately the work is finished, and has for object the total elimination of the essential oil which has served as vehicle for the colours. There are several methods of attaining this result, the following being the most time honoured and effective. The material required is very simple : a small spirit lamp and a kind of little shovel formed of wide-meshed metallic gauze and provided with a wooden handle. As already said, constant attention must be given to avoid a fatal blistering of the colours.

The article must be carefully placed in the centre of the wire shovel (several articles at a time if their size permits) ; then holding the shovel by the handle it is held over the flame of the spirit lamp for from ten to fifteen seconds to start with (see Plate V). After this brief exposure to the heat the shovel is withdrawn

PLATE V



Studio for painting on enamel and enamelling



Mixing colours for painting
on enamel



Painting on enamel



Enamel painter at his bench



Drying out an enamel painting
over spirit lamp

for about thirty seconds, this permits the article to warm up gently. This procedure is repeated two or three times, when the essential oil will begin to evaporate, throwing off a faint smoke : without hurrying too much, the operation is repeated, gradually approaching the shovel to the top of the flame until at last it actually touches. After each application of the heat for about ten seconds sufficient time must be allowed for the smoke to escape entirely before applying further heat. After about eight or ten applications it will be noted that no more smoke arises.

Heat is applied once more, this time for one or two minutes so that the essential oil may be entirely evaporated. Finally, it will be noticed that during the evaporation the colours change in appearance, taking on firstly a uniform sombre brown tone, gradually lightening to a pale coffee colour and in parts to a chalky white when the evaporation is complete. To save time a good many craftsmen effect the drying by gradually approaching the article to the mouth of the muffle, but this risky method is not very practical, particularly if the firing does not take place in the establishment where the painting was executed. The firing, this operation far more delicate than the preceding, can take place immediately after the drying or at any other time, providing the article (painted and dried) is protected from all dust.

As in enamelling the furnace must be at its normal working heat, the article must be placed, carefully, on one of the fireclay planches, which in turn must be placed 10 or 15 cm. from the mouth of the muffle ; the plate must be turned slowly and gradually approached nearer the muffle so that the article will

not heat up too rapidly. Vigilance not less sustained than when firing enamels must now be exercised for the very short time required to vitrify the colours. There is but a very narrow margin between the moment when the firing will have reached its normal point, and that when the point will be overpassed and the work more or less marred.

So, by means of a long pair of tongs, the planche must be placed on the little fireclay support already in the muffle, on which it should balance ; then with eyes constantly fixed on the article the planche must be turned, slowly, but without stoppage, so that the heat is spread equally. The length of time for this operation will vary ten, twenty, thirty seconds, or even more, according to the form, size, or thickness of the article. The exterior of this will be first and mainly affected by the heat, although the centre will also be affected by the refraction from the dome of the muffle. The surest guide is the change in the appearance of the painting during the firing, and that change must be carefully watched : matt and sombre at first the painting lightens up as the colours vitrify. As soon as the glazing is manifest the planche must then be gently withdrawn, and if it is judged that the colours are not fully vitrified, showing still a certain lack of glaze, it will be quite safe to give a further firing, particularly if certain colours slightly harder than the others are not quite vitrified.

A brief description may here be given of the type of enamels called "Limoges," name taken from the town of Limoge, cradle of the masters who created that art, and whose traditions are carried on to this day, not only in their birthplace but in many countries,

and under various forms adapted to modern requirements.

This process has been described as "painter's enamels" or "painting in enamel," so as to indicate decisively that it is a process in which the enamels play a major and vitrifiable colours a minor part.

"Limoges" is thus a vitrified painting in relief producing a sculptural effect, and executed with whites of a special composition, sometimes on a background of sombre-toned opaque enamels, but more usually on dark transparent enamels, and in these days very frequently on light transparent enamels, more particularly on small articles of jewellery, etc.

As just mentioned, the whites employed are somewhat peculiar; their composition varies but their essential quality is that they remain semi-transparent after firing, permitting light to penetrate more or less, thus giving vivacity to the unctuous and supple medium. Thanks to this quality all kinds of subjects can be treated, mainly portraits, allegorical scenes, ornaments, etc. Usually the white is left in its natural condition, but occasionally a minute portion of vitrifiable colour is incorporated with it, blood red, carmine, etc., to add warmth and animation to its otherwise somewhat cold tones; or a practically similar result can be obtained by giving finally a faint wash of one of these colours, over portions or the whole of the subject.

In the way of materials: essential oil which should be fairly fluid—semi-fat, sable brushes, and several "points" of steel, or better still, hard wood, as this work combines in itself both painting and bas-relief.

It is highly advisable to use only whites freshly

prepared, and for ease of execution it is well to make two or three mixtures with varying proportion of oil, accordingly as one wishes to lay a thin ground or masses of fairly pronounced thickness.

The designs should be treated in masses, heavy for the high lights, then in gradually diminishing thickness for the half tones, the background of enamel forming the shadows.

The methods of execution adopted by different artists vary considerably, but a sure eye and a certain "virtuosity" are necessary, as to be successful and possess its distinctive character the work must be executed with a certain dash and elegance, and in a relatively short time, to obviate the risk of the paint sinking, whereby its true style would be lost. Brushes should be used by preference for laying on the masses, and points for working out the shadows and modelling the subject. The work is usually executed in two or three fires, occasionally more according to the amount of relief required, the finest details and high lights are left for the last firing and naturally are applied with white of the greatest possible consistency.

Further, the high lights can be accentuated to some extent, if, after the painting is finished but before drying, the artist breathes gently on to the work two or three times.

The firing of "Limoges" enamels differs in some essentials from that of other processes. In the first place, these paintings must never be dried over the spirit lamp or by other similar means, but solely by the heat of the furnace, at normal working temperature, and with the door open. In view of the considerable quantity of oil employed and the thickness of the

painting, the drying must be effected extremely slowly, the article at the start being placed well away from the zone of heat, and then gradually moved nearer and nearer to the mouth of the furnace. The subject will first darken and then very slowly clear, and when at length it turns a chalky white—proof that the oil has totally evaporated—it is placed in the furnace. All the precautions relating to firing in general must be scrupulously observed, but special care must be taken not to carry the glazing too far, at any rate for the first fires, as this would destroy the vigour of the work.

Be it added that Limoges is never covered with flux; this naturally means that it is somewhat fragile and should therefore be reserved for articles which are not liable to be rubbed.

More often than not, the large artistic "Limoges" are treated in conjunction with translucent or transparent enamels of various shades, in the heart of which the work "en blanc" harmonises and blends in a most happy manner. Occasionally also Limoges and the enamels forming the ground are bound together with delicate waves of gold, which, however, should be used with great discretion.

Fluxing (covering with flux).

This is the final and supreme test to which not only the painting but the article itself must be submitted.

The object is to cover the painted subject with a protective glazing, which at the same time brightens and harmonises the colours. It has already been explained why a painting which has been boldly

treated and with a certain solidity will offer greater resistance to the absorbent tendency of the flux than a painting executed in thin delicate washes. Nevertheless, the application of flux even to a painting specially prepared for that purpose must be executed according to well-defined and rigid rules.

In the first place, the flux must be specially selected for that purpose, and according to the form of the article or the metal of which it is made, should be of greater or less fusibility. The flux must firstly be ground and washed according to the rules laid down in Chapter VI for enamels in general, but with this difference, the flux must be reduced to a state of extreme fineness, but at the same time the grain must be absolutely uniform, remembering also that the more freshly the flux is prepared the more limpid and clear will it appear when fired on to the painting.

Thus, lack of care or the use of stale flux which has not been sufficiently refreshed, will often result in an important work being irretrievably spoilt, the painting appearing muddy and the surface marred by blisters and pinholes.

Further, the acidulation of flux intended for covering must be carried much further than in the case of other enamels. Certain craftsmen who specialise in this class of work, do not hesitate to submit a grinding of about 20 grms of flux, freed from water, to the action of 12 to 20 drops of pure nitric acid for a period of an hour or an hour and a half, being careful to stir the whole from time to time. As usual, the acid must be removed by copious washing.

The flux having been properly prepared, proceed as follows :—

A painting can be covered with flux at any time after its completion, but if during the interval it has been handled or soiled in any way, it must be well washed, and then carefully dried in front of the muffle to remove all traces of grease, etc. The enamel is then applied according to the rules for other enamels, but by preference with a point having an end like a flattened spoon so as not to scratch the painting; better still, an ordinary brush with soft hairs can be used, being very suitable for this purpose.

Whichever instrument is used, it is most advisable to apply the flux in two or even three very thin and regular coats. This point is of such capital importance that too great stress cannot be laid upon it. To be precise, each coat must be thin enough to permit the painting to show through as though it were covered with a thin veil or piece of tracing paper. This effect must be clearly apparent while the flux is being applied and must persist even when the flux has been *dried*. Each coat must, of course, be fired before the next is applied, according to the rules, the furnace being at full working heat.

Here, again, keeping a careful eye on the work, care must be taken to avoid overfiring. The first fire must be only sufficient to frit or bind the flux, that is to say it must not go beyond the first stage of vitrification, being just sufficient to allow the second coat to be applied, this also must have a very moderate fire. After the second coat, particularly for special work, it is advisable to file the surface lightly to equalise it, then after the usual brushing and washing, it is refired and the final coat of flux applied. Some enamellers leave the filing until after the third coat.

The last firing, while not excessive, must be carried further than those preceding, sufficient indeed to glaze the flux satisfactorily. Large surfaces should be smoothed with a spatula before firing, to ensure its perfect regularity. To conclude this chapter, it may be mentioned that certain enamellers employ designedly, especially for rich works on gold, a flux called semi-hard, which is polished on the lathe in the manner already described.

It was mentioned at the beginning of these notes relating to paintings on enamel, that these were usually executed on a ground of white opaque enamel, but at the same time a special enamel called *pâte*, on which a few remarks will be made, is used for certain purposes. *Pâte* enamel, sometimes called antique white, has a composition entirely different from that of the other ordinary white enamels. *pâte* enamel can be made in a pure white, but it is usually preferred with a slight ivory or greenish tint. It has the further peculiarity of being to some degree semi-transparent, and as this under certain circumstances might be a drawback, *pâte* enamel is not usually applied direct to the metal but on one or even two coats of ordinary white enamel which serves as base. The essential property of *pâte* enamel is that it is to a certain extent penetrated by the colours, to which it imparts great freshness and vivacity, this property is taken advantage of in the case of portraits, particularly of young women or children, which gain infinite charm and purity in the carnations.

Flower paintings on this class of enamel are full of life.

Pâte enamel is manufactured in two distinct classes, one of which can be covered with flux and one not.

To conclude this brief summary, a few remarks may be made on the use of gold and silver in enamel painting. In this form the use of these metals is somewhat limited ; they are of use, however, under certain circumstances to indicate little metallic notes, such as palms in allegorical subjects, buttons, decorations and the trimmings of military and other uniforms, etc.

Still more rarely are these metals used for fields or large flat spaces. There are various preparations of these metals each serving their special purposes, but only one, the most time honoured, will be considered here, that is the burnish gold (or silver) preparations which are polished after firing.

These two metals as prepared for this purpose are in the form of impalpable powders, the gold a rich brown, the silver alone having its natural appearance. These powders are mixed with essential oil in exactly the same manner as the colours for painting but always with a fat oil, so as to make as stiff a paste as possible. The ornaments or surface which are to produce a metallic effect must be painted at the last moment, soundly and thickly, and without half-tones, as these would inevitably be a failure. Drying is as usual and the firing must be moderate. The "gold fire" (*feu d'or*, as it is termed), which also includes silver, must not exceed dull red, that is a very moderate heat : the moment must be carefully watched when the metal softens slightly, but this limit must not be exceeded, as these preparations are very fusible and would be affected by an excess of heat.

After firing these metals will be found to adhere to

the painting as they would to any other enamel, but they do not yet possess their natural metallic brilliance, particularly the gold, which still has a brown matt appearance. Their brilliancy is attained by burnishing, that is by rubbing gently with a burnisher made of agate moistened with soapy water or vinegar and water. For surfaces of any extent, the burnishing must always be in one direction only, to avoid stripiness. A few moments suffice to give the metal its natural brilliance.

This concludes the exposition of this delicate art of which the author has done his utmost to give a clear and succinct description.

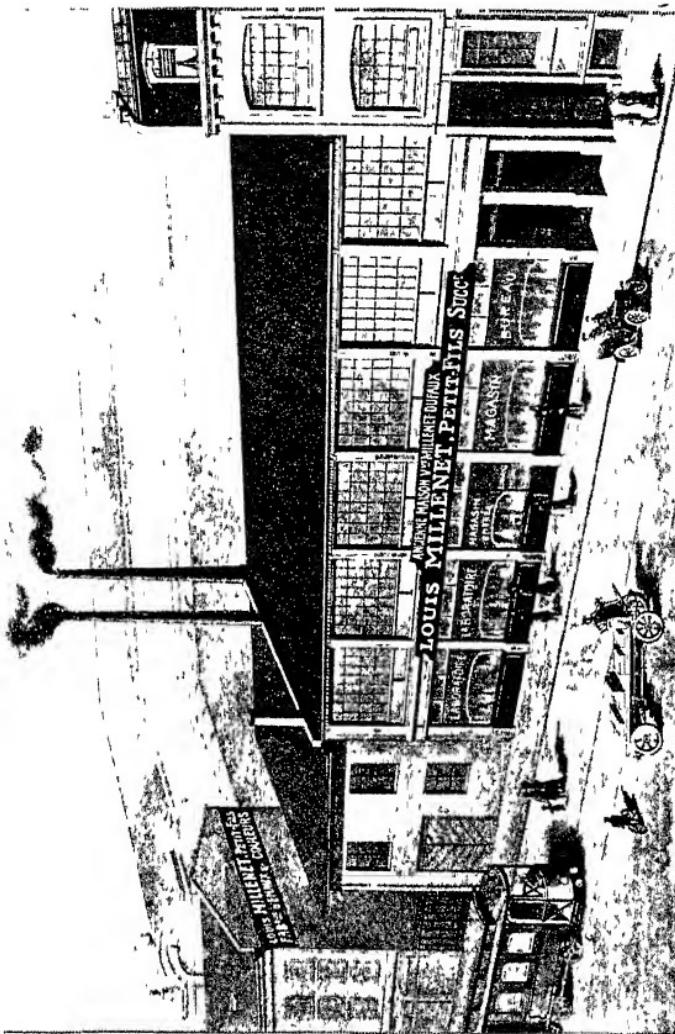
A certain number of photographic reproductions are included, which it is hoped will help to illustrate the processes treated of in this work, rendering them clearer and therefore more useful to the uninitiated.

Manufacturer of
ENAMELS
and Colours for
PAINTING on
ENAMEL.

All Accessories supplied

Founded in 1835

LOUIS DUFaux, PÈRE
AND CONTINUED BY
•**YVE MILLENET-DUFaux**



LOUIS MILLENET, PETIT-FILS, Succr.

19 Rue de la Coulouvrenière 19, Geneva, Switzerland.

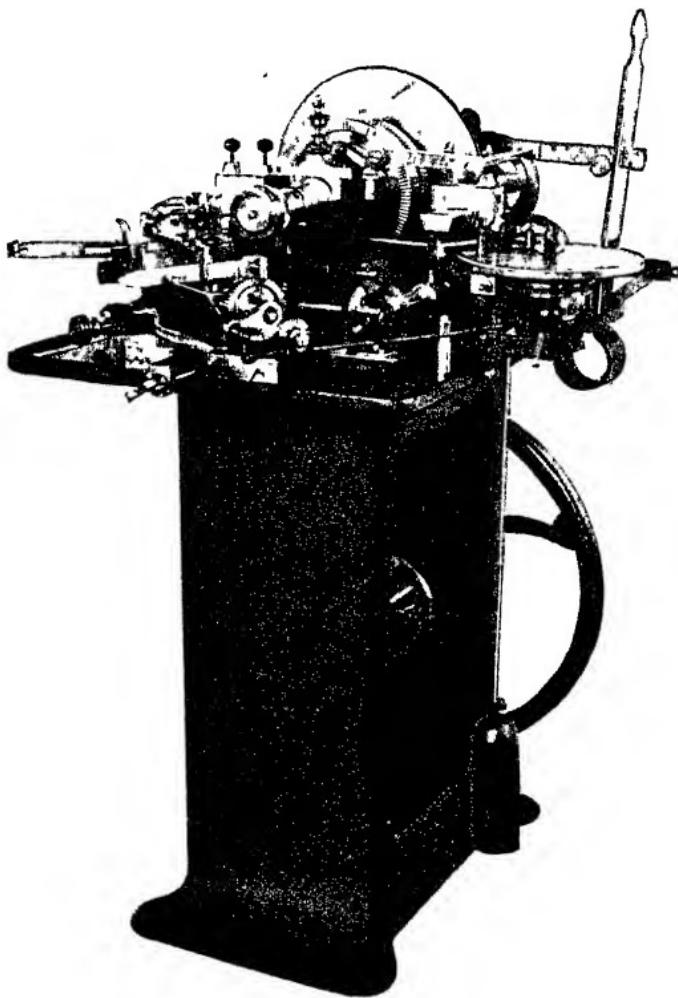
THE ONLY MANUFACTORY ESTABLISHED IN SWITZERLAND.

LIENHARD & CO.

(Established 1895)

LA CHAUX-DE-FONDS (Switzerland.)

Firm known all over the world for the construction of engraving
and engine-turning machines.



Accuracy, High Precision and Finish are the predominant
features of our Machines.

ESTABLISHED FOR



OVER A CENTURY.

JOHNSON, MATTHEY & CO., LTD.

REFINERS AND ASSAYERS.

Manufacturers of PRECIOUS METALS in all forms
for the JEWELLERY and ALLIED TRADES.

SPECIAL ATTENTION is drawn to our specialities for the
metal enamelling trade:

9 ct. (No. 185a) GOLD ALLOY

highly recommended.

SILVER

suitable for enamelling.

Quotations sent upon application stating full requirements.

76/83, HATTON GARDEN, LONDON, E.C.1.

Telephone. Holborn 6830/8 Telegrams "Matthey, Smith, London"

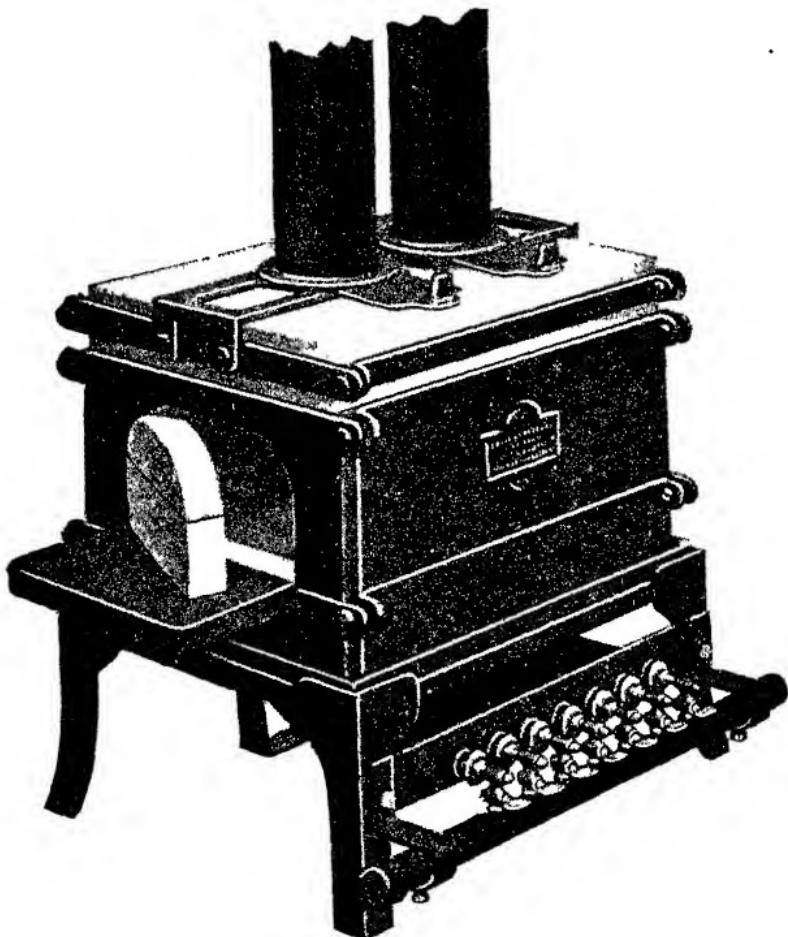
BIRMINGHAM : 71/3 Vittoria Street.

FLETCHER, RUSSELL & CO., LTD.

WARRINGTON,

AND 4, BERNERS STREET, LONDON, W.1.

PERFECTED MUFFLE FURNACES



FOR FIRING ENAMEL ON METAL, POTTERY WARE, &c.

These Furnaces are the most up to date of their kind, and are fitted with atmospheric burners to work at main pressure, and arranged with Gas and Air Adjusters for easy adaptation to coal gas of any calorific value.

These Furnaces are stocked in a LARGE RANGE OF SIZES.

FULL PARTICULARS ON APPLICATION

(RADIATION LTD, Proprietors)

A SELECTION OF
LOCKWOOD'S MANUALS

					s.	d.
Alternating Currents.	LARNER	.	.	.	6	0
Aluminium Repairing.	PLATT	.	.	.	3	0
Art of Building.	ALLEN	.	.	.	6	0
Bees for Pleasure and Profit.	SAMSON	.	.	.	3	6
Boot Repairing.	LORD	.	.	.	5	0
Brick and Tile Manufacture.	SEARLE	.	.	.	7	6
Bricklaying.	HAMMOND	.	.	.	2	6
Brickwork.	WALKER	.	.	.	2	6
Builders' Accounts.	KEEN	.	.	.	5	0
Butter and Cheese.	THOMSON	.	.	.	4	0
Cabinet Maker's Guide.	BITMEAD	.	.	.	3	6
Carpentry and Joinery.	TREDGOLD	.	.	.	6	0
Chemistry (Elements).	BASSETT	.	.	.	5	0
Chemistry (Practical).	MARTIN	.	.	.	2	6
Clock Repairing and Making.	GARRARD	.	.	.	6	0
Coal Mining.	COCKIN	.	.	.	6	0
Colour Mixing and Paint Work.	CARY	.	.	.	2	6
Commercial Poultry Farming.	TOOVEY	.	.	.	6	0
Cotton Industry.	CRABTREE	.	.	.	6	0
Crop Production.	HEPBURN	.	.	.	7	6
Damp Walls.	BLAKE	.	.	.	8	6
Decorator's and Renovator's Assistant		.	.	.	2	6
Electric Light Fitting.	URQUHART	.	.	.	5	0
Electrical Engineering.	ALEXANDER	.	.	.	3	0
Electrical Horology.	LANGMAN	.	.	.	7	6
Electro-Plating.	WATT	.	.	.	5	0
Engineering Drawing.	MALDEN	.	.	.	8	6
Engineers' Measuring Tools.	PULL	.	.	.	4	6
Engineers' Screw Cutting.	PULL	.	.	.	2	6
French Polishing and Enamelling.	BITMEAD	.	.	.	2	6
Fretcutting.	MAKINSON	.	.	.	2	6
Garden Receipts.	QUINN and OWEN	.	.	.	2	6
Gasfitting and Appliances.	BRIGGS	.	.	.	6	0
Gas Meters.	GILBERT	.	.	.	7	6
Geometry for Technical Students.	SPRAGUE	.	.	.	1	6
Goldsmith's Handbook.	GEE	.	.	.	6	0

LONDON . CROSBY LOCKWOOD & SON

LOCKWOOD'S MANUALS—*continued.*

			s. d.
Handrailing and Staircasing.	COLLINGS . . .		3 6
House Painting, Graining, etc.	DAVIDSON . . .		7 6
Illuminating and Missal Painting.	WHITHARD . . .		6 0
Land Ready Reckoner	ARMAN . . .		4 0
Lathe Work.	HASLUCK . . .		6 0
Letter Painting Made Easy.	BADENOCK . . .		2 0
Marble Decoration	BLAGROVE . . .		3 6
Mechanical Dentistry.	HUNTER . . .		6 0
Metal Plate Work.	BARRETT . . .		3 6
Mining Calculations	O'DONAHUE . . .		3 6
Motor Car Mechanism and Management.	SHEPHERD . . .		4 6
Motor Tyres.	FERGUSON . . .		3 6
Physics and Chemistry of Mining.	BYROM . . .		6 0
Pigs and Bacon Curing.	DAVIES . . .		4 6
Plastering.	KEMP . . .		3 0
Plumbing (Two Vols.).	BLAKE . . .	(each)	6 0
Pot Plant Culture.	DAVIDSON . . .		2 6
Radio and High Frequency Currents.	LARNER . . .		3 6
Railway Points and Crossings	DOBSON . . .		6 0
Roof Carpentry.	COLLINGS . . .		2 6
Sheet Metal Work.	HORNER . . .		6 0
Slide Rule.	HOARE . . .		4 0
Steel Square and Roofing	DRAPER . . .		2 6
Superficial Measurement.	HAWKINS . . .		4 0
Surveying.	BAKER and LESTON . . .		3 6
Upholstery and Cutting Out.	BITIMEAD . . .		2 6
Valuation Tables.	M'CAW . . .		5 0
Vegetable Culture.	DAVIDSON . . .		2 6
Veterinary Aid.	ARCHER . . .		7 6
Watch Repairing and Cleaning.	GARRARD . . .		6 0
Wireless Telephones.	ERSKINE-MURRAY . . .		4 6
Woodcarving for Amateurs	A LADY . . .		2 6
Woodworking Machinery.	BALL . . .		3 6

¶ Additional volumes in this Series are constantly being published.
Latest list will be sent on application.